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Environmental transition through social change and lobbying by citizens

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Abstract

While environmental values are spreading among societies, they hardly lead to effective political actions. This may be due to an overestimation of the sharing of those values among people, or to a lack of political power of environmentalists *vis-à-vis* materialist citizens. We propose a theoretical model to investigate these two channels, based on a setup *a la* Grossman and Helpman (1994), in which lobby is a strategy available to social groups, in order to influence the government on environmental taxes. Because societies have being historically marked by materialist habits, citizens sharing those habits face lower costs when getting organized. By considering endogenous lobby formation *a la* Mitra (1999), we show that, in order for environmental and materialist lobbies to coexist, the society must be mixed enough. Based on a dynamic framework *a la* Besley and Persson (2019), we investigate how social values change over time. Whenever lobbying by materialists prevails, a unique social equilibrium exists, featuring a stable hegemony by materialist values. If environmentalists get organized too, a second social equilibrium emerges, that is locally stable and more favorable to them. However, the threshold might be very high, above which the cultural transition effectively takes off. By calibrating the model, we study counter-acting forces allowing to improve the odds of the environmental transition, such as cultural mutations, social-signaling, and lowering organizational costs. Finally, we provide policy implications.

Keywords: Lobby, environmentalism, carbon tax, environmental policy, social change

JEL codes: A13, D71, D72, H23

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1 Introduction

More and more people are aware of climate change and the responsibilities of human beings in this respect, especially among the youth. Besides Gretha Thunberg, who is highly visible and mediatized, a majority of young people around the planet is worried about climate change.[1] In spite of this, and while older persons also put increasing weight on this topic worldwide, societies slowly accomplish a pendulum movement on their path toward environmentalism.

Generally, when a topic is widely spread among the population, it results in concrete actions by politics. This is hardly the case with climate change. This inability to concretize into actions by politicians is either due to an overestimation of the importance of the climate change topic in the general population, hence political action correctly reflects the overall preferences, or it is due to a lack of political power of those advocating in favor of the environment.[2] The former scenario would mean that environmental concerns have not spread enough, so that the cultural transition favoring pro-climate action is ongoing but far from achieved. In the latter case, it would mean that either the opponents to climate change have too much power and/or that those in favor do not have enough. The present paper is about these two channels and seeks to analyze how they influence each other. Hence, values, social change, and political power lie at the heart of our analysis.

Sociologists have long been exploring the mechanisms of social change in affluent post-war societies (see, among others, Cotgrove and Duff, 1981). The authors have considered that historically-rooted materialist values would leave room to post-materialism, as an expression of the search for individual well-being through freedom, equality, and ecology (Inglehart, 1977). Coherently, they have assumed that environmentalism is a prominent form of post-materialism. Moscovici (1976) has made explicit the theory of social representation. In particular, he has posited that what becomes social norms comes from science. Hence, given the tremendous amount of scientific evidence about humans causing climate change, the explanation for environmentalism not being a dominant social norm could indeed be the lack of political power of environmentalists.

In economics, several papers have dealt with the question of social change and cultural dynamics. In particular, we are interested in contributions in-

[1] See, for instance, the Pan-European Survey ordered by ClimateofChange to Ipsos released in 2021, showing that 85% of young Europeans (15-35 y.o) are either fairly, very, or extremely worried about Climate Change. As for the USA, a poll realized for 4-H among teenagers (13-19 y.o) highlights that "addressing climate change NOW" is a top priority for 84% of them. The UNESCO has also released a survey report revealing that 70% of young people question the quality of the education they receive about climate change.

[2] Indeed, this could also be due to political coalitions not being strong enough to sustain green and redistributive policies.

vestigating the transition from materialist to environmentalist values, such as the paper by Besley and Persson (2019) and its sequel (Besley and Persson, 2020 and Besley and Persson, 2023). In a model with values' transmission, Besley and Persson (2019) show that politics may hinder or foster the movement towards environmentalism because of policy choices that are made by the population. To put it quickly, a generation of citizens may vote for a policy that will favor the well-being of materialists, and reduce the well-being of environmentalists, thus inducing parents to prefer their children to become materialists in order to achieve a better utility.

In the above papers, the choice of using elections as the key political mechanism amounts to considering that climate change is an electoral stake. We consider this is not the case. Instead, we consider that climate change policy is determined by an incumbent government. In order to influence its determination, special interests groups will practice lobbying. In our model, we rely on a framework *à la* Grossman and Helpman (1994), underlining how lobbying may entail biases and distortions in public policies. Unlike contributions based on persuasion games, such as Cheikbossian and Hafidi (2022), in our model, as in Besley and Persson (2019), the population is divided into two homogenous groups of citizens, materialists and environmentalists. In order to lobby, each special interest group must get organized, which will be costly, due to the presence of fixed organizational costs, according to the seminal contribution by Mitra (1999). Whether each lobby is formed or not will affect the equilibrium policy choices, and therefore the incentives for parents to raise their children as future environmentalists or future materialists.

The cultural balance within the society is a crucial real world feature, which is particularly relevant in our framework. In this respect, our analysis aims to answer several fundamental questions. First, how do lobbies stemming from social groups affect the environmental policy ? And related to this, how does the carbon tax change following a modification in the weight of materialist vs. environmentalist citizens' lobbying ? Finally, do lobbies entail long-run consequences on social change, i.e. do they affect the cultural balance within societies ? So, in this paper, we investigate both short- and long-term effects stemming from the working of lobbies. More specifically, the short-term impact regards the fiscal system, i.e. the tax structure, while the long-term effects are related to the way in which lobbies affect the spreading of ideologies and social values, and ultimately contribute to cultural hegemony.

To provide answers to our research questions, we investigate the coevolution of social configurations and lobbying structures. In order to fit the historical path that societies have followed, we assume that, in the beginning, citizens predominantly share materialist values. As a matter of fact, materialism has long been (and, indeed, still is) deeply rooted in our societies, it shapes citizens' habits (such as, consumption), and also permeates

political and economic leverages of power, at all levels. Coherently, materialist citizens can take advantage of this situation, namely when it comes to organizing into lobbies.

More specifically, in order to represent this historically-rooted advantage, we make the assumption that materialist citizens face lower lobbying organizational costs than environmentalists do. We initially investigate the features of social change when materialist lobbying prevails. Then, we generalize our framework and study the conditions under which environmentalists manage to counterbalance the materialists' pressure onto the government, by getting organized as a lobby too. We identify that, in order to have such a coexistence of lobbies, the society must be mixed enough. It appears that, when both lobbies are active, the government captures all the surplus generated by its political relationships with the two interest groups.

To investigate the impact of lobbying on social change, we develop a setup analogous to Besley and Persson (2019), and study how society evolves when allowing the proportion of environmentalists to vary across time. Our theoretical analysis shows that, under materialist lobbying, the only stable equilibrium for society entails cultural hegemony by materialist values, and leaves no room for the ecological transition. However, under the condition that a second environmentalist lobby emerges, another social equilibrium appears, that is locally stable, and may involve quite an important proportion of environmentalists. Nevertheless, because societies are initially characterized by a materialist hegemony, the thresholds that effectively ensure the transition towards environmentalism may hardly be met. Moreover, even if transition starts it could converge to a rather small group of environmentalists. Hence, the rise of environmentalist lobbying is not sufficient for environmentalist citizens to be able to attain a cultural hegemony by their own. So, societies are caught in a long-lasting materialist trap.

Finally, we turn to study the counteracting forces which may alter the path of social change, and facilitate the convergence to environmentalist values. In the first place, we investigate of possibility of mutations in the population of materialists, that may mitigate the previously identified dead-end. While, in our basic framework, two materialist parents necessarily raise future materialist adults, we also consider the possibility for the latter to randomly change their minds due to concerns regarding, for instance, climate change or extreme events. If the probability of mutation is high, then environmentalists may become strong enough, in order to escape the materialist trap in which societies are stuck. Then, we show that lowering organizational costs for environmentalist lobbying, and boosting the social-signaling that stems from environmental values, may help off the process of cultural transition.

The remaining of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 introduces and develops the model starting with a description of our simple society and its citizens, and finishing with

the different equilibrium lobbying configurations that may emerge. Section 4 deals with social change by introducing dynamics within the society. Section 5 explores possible scenarios that may favor the emergence a cultural transition towards environmentalism through various mechanisms, and finally the last section concludes.

2 Literature

Social research has long analyzed how values spread within a society. In the 70s, Serge Moscovici developed the theory of *social representation* to study how common values may emerge within a group or even the whole society (Moscovici, 1976). More specifically, he posited that social norms come from science. Coherently, he also investigated how scientific findings move from the academic fields to the general opinion. Given that there is robust scientific evidence about humans causing environmental damages, a simple interpretation of the highly complex theory of Moscovici is that the problem (about the environmentalist cultural transition not taking place) comes from the relative power of materialists with respect to environmentalists. The former are too powerful and prevent ecology from appearing at the top priority of political agendas despite opinion being well aware of the ecological issues. More recently, sociology also has sought to uncover the keys to successful social movements, as in Crutchfield (2018). Sociologists have also studied the way in which everyday life can impact on social change, as, for instance, Yates (2022).

In economics, social change has been tackled mostly in relation to the issue of endogenous individual and social preferences, as in Bisin and Verdier (2001) or more recently Bisin and Verdier (2017), Touré (2021), and Wu and Zhang (2022). Lastly, some contributions have focused on environmentalist values, the main question being about how to uncover the two-way causality between economic decisions (for instance, about green consumption or production) and changing cultural values (Kahn and Lall, 2022, Mattauch et al., 2022).

Besley and Persson (2019) and Besley and Persson (2023) have extensively studied social change following environmental tax policies that are selected by the government in line with electoral objectives, i.e., in order to maximize the chances of winning elections under probabilistic voting. The authors have shown that society would dynamically converge to a share of environmentalists, either equal to zero or equal to one, depending on initial conditions. To put it differently, spontaneous convergence to an ecological society would happen above a certain threshold, i.e., if $\mu \geqq \widetilde{\mu}$, μ being the share of environmentalists in the society. If this condition is not met, then it would converge to a totally materialist society. The government can cope with such a challenge by committing to a fixed tax rate $\widetilde{t} \geqq t_{em}\,(1)$. Provided

that $\widetilde{t}$ is sufficiently high (possibly tending to infinity), this commitment can ensure society to converge toward $\mu = 1$.

We depart from this analysis by taking into account the impact of lobbying by citizens. Hence, we propose a new framework to address the issue of politics and social change. Indeed, Besley and Persson (2023) consider as a special case the existence of firms' lobbying that might marginally influence the tax schedule. However, lobbying by the two social groups of citizens is not accounted for. By taking into account this aspect, we are able to obtain distinct features characterizing the tax schedules enforced by materialists vs. environmentalists contributions, thus entailing distinct patterns of social change. Moreover, we introduce an endogenous lobbying participation *à la* Mitra (1999) whereas in Besley and Persson (2023) lobbying participation is exogenous. As a matter of fact, they do acknowledge that endogenizing lobbying participation would be an interesting improvement. We shall see later in the paper that it indeed brings interesting results. One additional way in which we depart from Besley and Persson (2023) is that, as already stated in the introduction, environmental policy is decided by an incumbent government. We consider that, in general, environmental policy is regrettably not an electoral stake. For instance, in France for the last presidential election of 2022, purchasing power was by far the main reason explaining why French people decided to go to vote. The environment was not listed in the priorities of French voters.[3] Crossing over the Atlantic ocean, for the mid-terms election of 2022 in the USA, climate change was ranked only fourteenth by all registered voters (yet with a sharp difference between democratic and republican candidates supporters).[4]

Concerning lobbying, the economic literature has thoroughly investigated the institutional setup of lobbies. In this respect, a debate exists concerning the relative scope for individual vs. collective lobbying (Matsueda, 2020, and Redoano, 2010). In the real world, establishing collective interest groups is an important way for citizens to take political positions on relevant issues (De Bruycker et al., 2019). Empirical evidence suggests that collective lobbying is also relevant in globalized industries, namely for firms facing highly competitive markets (Bombardini and Trebbi, 2012), and for Global Value Chain firms (Zhang, 2022). From a theoretical point of view, if agents are given a chance to choose whether to lobby individually or collectively, a collective action's problem arises. This issue can be solved by assuming economies of scale in lobbying, i.e. common resources and/or fixed organizational costs. However, we also know that free riding is not always

[3] See this article (in French) on Ouest France https://www.ouest-france.fr/elections/presidentielle/presidentielle-le-vote-macron-n-est-clairement-pas-un-vote-d-adhesion-a2aea0ae-b7ff-11ec-8218-82176f0101f6.

[4] See this detailed article of the Pew Research Center, https://www.pewresearch.org/fact-tank/2022/11/03/key-facts-about-u-s-voter-priorities-ahead-of-the-2022-midterm-elections/.

an issue. Pecorino (1998) has indeed showed that it is not harder to maintain cooperation when the number of firms in a lobby increases. He also showed that even when converging to perfect competition it is not necessarily harder to maintain cooperation. As explained by Pecorino, one way to interpret this result is to consider that cooperation in lobbying activity is more complex than the simple trigger strategy he uses in his paper. While this might be true for firms (see Bombardini and Trebbi, 2012), we believe that the simple trigger strategy is probably consistent with the collective lobbying we develop in this paper.

Finally, it goes without saying that the most influent paper about lobbying is the one by Grossman and Helpman (1994). As already stated in the Introduction, we naturally build on their framework, which was inspired by Bernheim and Whinston (1986), and then use the additional work by Mitra (1999) when it comes to endogenize lobby participation.

3 The model

Our analysis is based on the two-class model by Besley and Persson (2019) and Besley and Persson (2020), which we modify in order to account for the role of lobbying from organized interest groups of citizens. Accordingly, we consider two different categories of citizens, i.e. environmentalists and materialists. These social types are characterized by their shared values with respect to environment and pollution. In this economy, total pollution is defined by the level of the aggregate consumption of a polluting good.

More precisely, environmentalists fiercely dislike pollution. Coherently, they are willing to restrict their consumption in order to avoid acquiring and consuming polluting goods. Conversely, materialists only mildly dislike pollution. Accordingly, they prefer to optimally diversify their consumption over polluting and non polluting goods.

In the model, the dynamics is uniquely cultural and is driven by a change in social values, which allows each social group to strive to achieve the cultural hegemony. Cultural change takes place in the long-run as a consequence of new-born children being socialized by their parents. Social mixity among parents is the key to cultural change, as we shall see in section 4.

Nevertheless, institutional change also takes place in the model. In fact, grown-up citizens make choices about getting collectively organized according to the existing cultural divide. For each generation of citizens, their choices determine the equilibrium configuration of lobbying which prevails at the institutional level. Hence, changing values dispersion in society yields changes in the relative share (and weight) of social groups of citizens, and yields consequences for the balance of power, and for lobbying.

The general structure of the model is recursive and characterized by the following steps: in step one, the initial share of environmentalists e within

the population (of dimension 1) is given and equal to μ,while materialist m are in proportion $1-\mu$; in step two, the equilibrium configuration for lobbying is determined, and the tax schedule defined as a consequence of lobbying activities by organized citizens; in step three, present period's payoffs and utilities are realized; in step four, cultural change takes place and values evolve in response to social change, thus leading to the next period's value of μ.

3.1 Static framework: environmentalists vs. materialists

We start by characterizing the static framework and the working of model at step one. Two goods are consumed. Individual consumption of the non-polluting good (which is also the numerary) is denoted n while c is the individual consumption of the polluting good whose price p is set equal to 1 for the sake of simplicity. All citizens earn the same income y. As for Besley and Persson (2019), our model features a redistributive transfer r to all individuals, which is financed by taxing the aggregate consumption of the polluting good C at a tax rate equal to t. This assumption about redistribution enables us to consider a more equal implementation of the foreseen carbon tax, which helps improving inequalities as suggested in the empirical work by Budolfson et al. (2021), for instance. Moreover, it is quite commonly considered that a redistribution of tax revenues to all citizens helps improving public support for taxation, as shown by Sommer et al. (2022) with respect to carbon taxes. In particular, the authors provide empirical results showing that using carbon tax revenues to finance green investments would amount to "preaching" to green citizens (who already support carbon taxes), while a redistribution to all citizens allows to broaden the spectrum of public support, namely for higher tax rates. In order to give our tax a full chance to be implemented, we select to stick to the above assumption of a redistribution scheme of tax revenues to all citizens.

Hence, the government budget constraint is $r = t \cdot C$, which delivers the per capita average level of redistribution. Pollution generates a negative externality which is proportional to the aggregate consumption of polluting goods and impacts both materialist citizens (through a coefficient λ) and environmentalists (through a higher coefficient, i.e. $\lambda + \theta$).[5]

Regarding the specifications of the utility functions and budget constraints, we follow Besley and Persson (2019). Concerning environmentalists, we assume that they do not get any utility from the consumption of polluting good. In this case, they set $c = 0$. Hence, only materialists acquire polluting good and the ex-post aggregate consumption of the good is equal to $C = (1-\mu) \cdot c$ which also defines the level of total pollution P, i.e., $P = C$. Given the individual budget constraint $y + r = n$, by replacing for P and n

[5]For empirical estimations of the value of θ see Orru *et al.* (2016 Orru et al. (2016)).

in the environmentalist utility function, we finally get:

$$\begin{aligned} U_e &= n - (\lambda + \theta) \cdot P + V(\mu) \\ &= V(\mu) - (\lambda + \theta - t) \cdot (1 - \mu) \cdot c + y \end{aligned} \tag{1}$$

More precisely, $V(\mu) = \chi \cdot \varphi(\mu)$ is the function that captures the effects of social-signalling and social respect gained from being an environmentalist, with coefficient $\chi > 0$. The importance of this effect also depends on the proportion μ of environmentalists in the society. Hence, there is an externality stemming from social networking around environmental values.

In order to qualify this effect, it is assumed that the social-signalling for environmentalism works through the observation of the polluting goods' individual consumption c. This is imperfectly observed with a probability equal to ρ. Hence, if $c > 0$ is not observed, it might be that the individual is an environmentalist, or an unobserved materialist. Based on the Bayes rule, whenever $c > 0$ is not observed, the conditional probability $\varphi(\mu)$ for anyone to be an environmentalist is equal to:[6]

$$\varphi(\mu) = \frac{\mu}{\mu + (1 - \rho) \cdot (1 - \mu)} \tag{2}$$

Turning to the specification of the individual utility function for materialists, we define:

$$U_m = \log(A \cdot c) + n - \lambda \cdot P \tag{3}$$

At the individual level, we obtain the expression of optimal polluting consumption by maximizing utility (3) under the individual budget constraint $y + r = (1 + t) \cdot c + n$, recalling that the price of the polluting good has been set equal to 1. By denoting $\alpha = \log(A) - 1$, we can write:[7]

$$\widehat{c}\,(t) = \arg\max \{\alpha + 1 + \log(c) + y + r - (1 + t) \cdot c\} = \frac{1}{1 + t} \tag{4}$$

We denote $v(t)$ the indirect utility function and obtain:

$$\begin{aligned} v(t) &= \alpha + 1 + \log(\widehat{c}\,(t)) - (1 + t) \cdot \widehat{c}\,(t) \\ &= \alpha - \log(1 + t) \end{aligned} \tag{5}$$

[6] $P(env/noc) = \frac{P(noc/env)P(env)}{P(noc/env)P(env)+P(noc/mat)P(mat)}$

[7] As in Besley and Persson (2019), the impact of individual c on aggregate consumption C, on pollution, and on redistribution is not taken into account by agents when making their optimal consumption decisions. Concerning the political decisions, Besley and Persson (2019) assume that each elector takes into account this externality when voting.

Hence, ex-post utility functions for materialists and environmentalists are:[8]

$$U_i(t,\mu) = \begin{cases} \chi \cdot \varphi(\mu) - (\lambda + \theta - t) \cdot (1-\mu) \cdot c + y & \text{if } i = e \\ v(t) - (\lambda - t) \cdot (1-\mu) \cdot \frac{1}{1+t} + y & \text{if } i = m \end{cases} \quad (6)$$

Finally, we stick to the parametric assumption made by Besley and Persson (2019), which entails that λ is small with respect to θ and α.

Condition 1 $\alpha - \log(1 + \lambda + \theta) < 0 < \alpha - \log(1 + \lambda)$

This is not a very stringent condition on λ and θ, given that the utility parameter α can be conveniently selected. In this respect, in our framework, we make the following additional parametric assumption.

Condition 2 $\alpha - \log\left(\frac{a}{1+a}(1 + \lambda + \theta)\right) > 0$

This ensures that materialist citizens always enjoy positive levels of indirect utility, when taxes are set according to lobbying by the organized materialist group.[9]

3.2 Lobbying on environmental tax

In this section, we modify the baseline model by allowing citizens to collectively lobby on taxation, i.e., to shape the government's fiscal policy. The Grossman and Helpman (1994) formalization relies on the truthful equilibrium concept developed by Bernheim and Whinston (1986) where lobbies sent contribution schedules to the government. These are incentives sent to the government in order to obtain a fiscal policy that better corresponds to the preferences of the lobby members.[10] Of course, for these incentives to work, the government has to care about contributions paid by special interest groups. Hence, an exchange of favors takes place between interest groups and the government. Concerning the environmental taxes, the materialist group aims to obtain a lower tax rate on polluting goods through lobbying. Indeed, this allows materialist citizens to improve their well-being, while

[8] $um(t,\mu) = \alpha + 1 + \log\left(\frac{1}{1+t}\right) + n - \lambda \cdot (1-\mu) \cdot \frac{1}{1+t} =$
$\alpha + 1 + \log\left(\frac{1}{1+t}\right) - (1+t) \cdot c - (\lambda - t) \cdot (1-\mu) \cdot \frac{1}{1+t} + y =$
$\alpha + 1 + \log\left(\frac{1}{1+t}\right) - 1 - (\lambda - t) \cdot (1-\mu) \cdot \frac{1}{1+t} + y = \alpha + \log\left(\frac{1}{1+t}\right) - (\lambda - t) \cdot (1-\mu) \cdot \frac{1}{1+t} + y$

[9] This assumption amounts at considering that materialist citizens are somewhat aware of the negative impact of pollution on their own utility, and therefore support a (minimal) pigouvian taxation.

[10] Relevant lobbying activities by organized categories of citizens may conceptually take many different forms such that influence by associations or organizations, pressure groups, mass' movements or social activisms.

policy makers benefit from contributions which are paid by the lobbying group. Conversely, the environmentalist lobby is also ready to pay direct contributions to the government, in exchange for higher environmental taxes which increase the welfare of citizens belonging to their lobby.

More precisely, in the model, lobbies are formed by all citizens who share equal values with respect to the environment. For the sake of simplicity, we consider that all those citizens get together, within their lobby, in order to pressure the government regarding the level of taxation on polluting goods. Coherently, environmentalist consumers might join to form one single ecological lobby, while all other consumers shall form a single materialist interest group. Based on this framework, three possible scenarios emerge: first, one single environmentalist lobby exists, second, one single materialist lobby exists, and third, two lobbies coexist, one being environmentalist while the other one is materialist-oriented.

Based on previous assumptions regarding citizens' utility functions (1) and (3), at time s, we can denote W_s the social welfare, while environmentalist and materialist groups' welfare are denoted by W_s^e and W_s^m:

$$\begin{aligned} W_s &= [(1-\mu_s)\cdot U_m(t_s,\mu_s)+\mu_s\cdot U_e(t_s,\mu_s)] && (7)\\ W_s^e &= \mu_s\cdot U_e(t_s,\mu_s) && (8)\\ W_s^m &= (1-\mu_s)\cdot U_m(t_s,\mu_s) && (9) \end{aligned}$$

We follow Grossman and Helpman (1994), and specify the government's objective function by considering that both direct contributions and social welfare matter, weighted according to a parameter $a \geq 0$:

$$W_s^G = Co_s^e + Co_s^m + a\cdot W_s(t_s,\mu_s) \tag{10}$$

with Co_s^e and Co_s^m being the contributions respectively delivered by environmentalist and materialist lobbyists, if both lobbies are operational. Regarding this point, we shall study in section 3.3 the conditions under which one or two lobbies might indeed exist. According to the analysis provided by Grossman and Helpman (1994), under the assumption of truthful Nash equilibria, the equilibrium tax rate $\widehat{t_s}$ can be obtained by solving the following maximization problem:[11]

$$\widehat{t_s} = \arg\max\left[W_s^e(t_s,\mu_s)+W_s^m(t_s,\mu_s)+a\cdot W_s(t_s,\mu_s)\right] \tag{11}$$

For notational convenience, in order to simplify presentation, we consider the parameter τ which characterizes lobbying configurations, i.e., $\tau = m$ corresponding to materialists being the sole lobby, $\tau = e$ for environmentalists'

[11] In a similar vein as Besley and Persson (2019), we assume that each lobby takes into account the impact of pollution on welfare when lobbying.

lobbying, and $\tau = em$ whenever lobbying is from both groups at the same time (or equivalently, if there is no lobbying at all).

Proposition 1 *Based on equations (7)-(9), we can solve (11) and find that the tax schedule maximizing the government's objective function, given lobbying configurations, is, for all* $\mu \neq 1$

$$\widehat{t}_{\tau,s} = \begin{array}{ll} \lambda + \frac{(1+\lambda+(1+a)\cdot\theta)\cdot\mu_s}{1+a} & if \quad \tau = e \\ \lambda - \frac{(1+\lambda-a\cdot\theta)\cdot\mu_s}{1+a} & if \quad \tau = m \\ \lambda + \theta \cdot \mu_s & if \ \tau = em \end{array} \tag{12}$$

We can show by calculations that $\widehat{t}_e(\mu_s) > \widehat{t}_{em}(\mu_s) > \widehat{t}_m(\mu_s)$ for any value of μ_s, except $\mu_s = 0$ for which all schedules give a common tax rate, i.e., λ. One should note that $\widehat{t}_{em}(\mu_s)$ maximizes social welfare and corresponds to the selected tax schedule under probabilistic voting (Besley and Persson, 2019). Under materialists' lobbying, the tax schedule is lower than with two-group (or no) lobbying. An opposite reasoning applies to environmentalist lobbying. Because they fiercely dislike pollution, environmentalists achieves to obtain, through lobbying, an upward shift in the tax schedule. This upward tax shift becomes more significant as the environmentalist group and lobby grow up in size, i.e., if μ_s increases over time. The case $\mu_s = 1$ is particular. In such a case, the optimization of the government corresponds to the maximization of the sole utility of environmentalists as according to equations (7), (8) and (9), the terms U_m disappear from equation (11). For $\mu_s = 1$, $\partial U_e/\partial t_s = 0$ for any t_s. Since there is no more consumer of the polluting good, there is nothing to tax anymore, hence any t_s is optimal in a society only populated with environmentalists.

Regarding the properties of the tax schedule, we can easily show that the tax rate generally increases when the share of environmentalists grows in the society. This positive relationship is confirmed by recent empirical results by Gatti et al. (2023). They find that a 10% increase of the spreading of environmental values [12] results in a 2.3 increase in the stringency of the environmental policies. It implies that the coefficient between the tax and the share of environmentalists should be around 1/4. In fact, if μ_s increases over time, then the government weights more strongly the welfare of environmentalist citizens. Because this group fiercely dislikes pollution, the government selects a higher tax rate on the polluting good.

Finally, under materialists' lobbying, we find that the tax schedule $\widehat{t}_m(\mu_s)$ is always lower than under two-group (or no) lobbying. Moreover, provided that $a < \frac{1+\lambda}{\theta}$, one has $\frac{\partial \widehat{t}_{m,s}(\mu_s)}{\partial \mu_s} < 0$. Accordingly, the more widely environmentalist values spread around the society, the lower the selected tax rate on polluting goods. Hence, the maximum tax is the pigouvian rate λ that is

[12] As measured by the Eurobarometer data on climate change.

reached when materialists are the only social group ($\mu_s = 0$). Because materialists suffer from pollution, and benefit from redistribution, their preferred tax is positive.[13] If there is no cultural mixity, tax revenues are entirely redistributed by the government to materialists. Hence, the tax does not negatively affect materialists' purchase power. As a consequence, they are ready to be taxed in order for consumption to be partially diverted from polluting to non polluting goods, thus reducing pollution. However, when the environmentalists' share increases within society, materialists are no longer alone to get the benefits from redistribution, although they entirely support the tax burden. Hence, they become more opposed to this tax, the higher the environmentalists' share within the population.[14]

Although a downward sloping tax schedule is not necessary to our results, it should be noted that condition $a < \frac{1+\lambda}{\theta}$ does not appear to be very stringent. According to Gawande and Bandyopadhyay (2000), the lowest empirically estimated values of a are about 3. Based on the following set of parameters' values, which are used for calibrations reported in figure 1, this leaves quite a reasonable flexibility for selecting appropriate values of a:

$$\begin{array}{ccccc} \alpha & \theta & \lambda & \chi & \rho \\ 0.25 & 0.1 & 0.2 & 0.045 & 0.5 \end{array} \tag{13}$$

which gives $\frac{1+\lambda}{\theta} = 12$. The condition can be further weakened by modifying the selected values of θ and λ. Parameters θ and λ measure the impact of pollution on individual welfare. Therefore, we select a value of λ that correspond to a reasonable empirical estimate of the average subjective importance of environmental concerns.[15] The value of θ can be adjusted to account for a more or less important divide between materialist and environmentalist citizens. ρ is the probability of correctly observing polluting consumption and we set it equal to $\frac{1}{2}$. We do not have a *a priori* concerning the value of the social signaling parameter χ. Hence, we start by considering a relatively low value, but we shall consider positive shocks to social signalling in section 5. Finally, parameter α is a scalar characterizing the utility function of materialist citizens and its value is selected in order to

[13] One should note that, in the lobbying deal, the government will always try to enforce a positive tax because of the welfare effects of pollution. Hence, our present result that materialists agree with a piguvian tax gives them a chance to implement a reasonable lobbying strategy. We will see in section 4.2 that they instead enforce a predatory lobbying, with respect to environmentalist values and citizens.

[14] In this case, for $\mu = 1$, the tax rate is the lowest: $t_m(1) = \lambda - \frac{1+\lambda-a\cdot\theta}{1+a}$. Then, there exists a $\overline{\mu}$ such that, for $\mu_{s+1} < \overline{\mu}$, one has $t_m(\mu_{s+1}) > 0$. For $\frac{1+\lambda}{\theta} > a > \frac{1}{\lambda+\theta}$, the tax rate is decreasing with μ, but $\overline{\mu} > 1$, and therefore $t_m(1) > 0$.

[15] As an example, Eurobarometer data over the period 2009-2019 show that the share of respondents considering climate change as the most severe global challenge is on average equal to 0.18 (maximum and minimum values are respectively equal to 0.5 and 0.039). Freely available data from Pew Research Center show that, on a worldwide scale, a medians of 0.26 respondent consider that climate change is affecting their lives.

fulfill modelling conditions and constraints, namely (1) and (2).

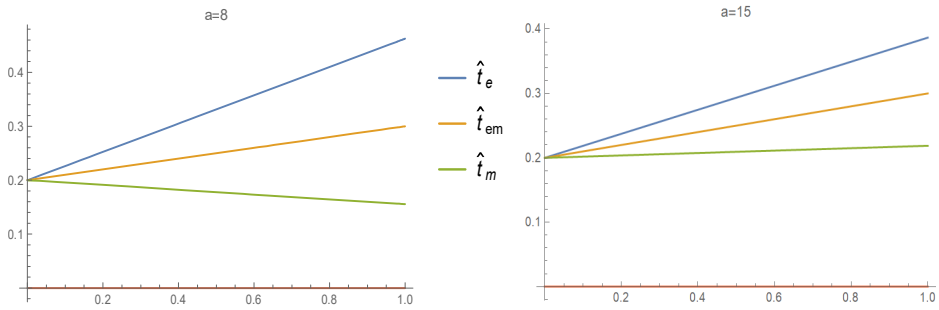

Figure 1: Tax schedules under environmentalist, materialist and two-lobby configurations

To conclude, we should stress that the analysis and results presented in the following sections do not specifically depend on the slope of the tax schedule being positive or negative, under materialists lobbying.

3.3 Equilibrium lobbying configurations

In this section, we lay out a framework to study the emergence of lobbies assembling all citizens sharing common values with respect to the environmental divide, i.e., on the one hand, environmentalists vs., on the other hand, materialists. This analysis is based on the seminal contributions by Grossman and Helpman (1994) and Mitra (1999). In particular, we follow Mitra (1999).This author considers fixed organizational costs that help explaining the dynamic setup of lobbies, and ranks lobbies according to the size of their those costs to define lobbies' emergence. In this respect, based on the sociological and political literature, we posit that materialist values have been shared within societies well before post-materialist ecological values. Coherently, we assume that fixed organizational costs are lower for the materialist lobby than for the environmentalist citizens who try and get collectively organized.

For the sake of clarity, we consider that a single interest group eventually emerges by assembling all materialist citizens, while environmentalists possibly get together within another single lobby. Hence, in principle, the institutional structure can be fully characterized by four scenarios: two "one lobby" cases, i.e., materialist lobbying versus environmentalist lobbying; one "two lobbies" case, i.e., lobbying by both materialists and environmentalists; and, finally, one "no lobby" scenario. Moreover, it should be stressed that the size of lobbies is endogenous with respect to social change. In fact, the share of environmentalist vs materialist citizens within society determines the size of the corresponding interest group, and the organized lobby. To put

it differently, for a given value of μ_s the lobby's size is constant. However, social change drives the trajectory of μ_s over time. Hence, at time $s+1$, a new generation of citizens is born and socialized, then μ_{s+1} will not necessarily be equal to μ_s. Accordingly, the respective size of environmentalist vs materialist lobby is affected by the changing distribution of values within society. Finally, each generation of citizens take its own decisions about lobbies' formation. Hence, the setup of a lobby configuration only applies to period s, and could be overcome by decisions taken by new generations regarding the matter.

Based on this characterization, we can draw on the analysis provided by Grossman and Helpman (1994) concerning equilibrium contributions and welfare, in the special cases when only one or two lobbies exist. According to Mitra (1999), we add fixed costs to the analysis, which are paid collectively by the lobby. In this case, fixed costs are not affordable from an individual point of view, which entails an incentive for people to get together and organize. In this section, we first study the equilibrium contributions and welfare that characterize our four lobbying scenarios. Then, we identify the sequential emergence of lobbies, given the existent structure of organizational costs. Moreover, in section 5, we will envisage a change in organizational costs across social groups.

Based on the analysis developed by Mitra (1999), a social group is able to become organized and form a lobby, if the following condition is met:[16]

$$NW^o(\mu_s) = W^o\left(\widehat{t}_o(\mu_s)\right) - Co(\mu_s) - W^{no}\left(\widehat{t}_{no}(\mu_s)\right) > F^o \qquad (14)$$

This conditions means that, in order for a lobby to be feasible, the organized social group should obtain a net welfare gain NW^o high enough to cover fixed organizational costs F^o. The net welfare gain is measured by the difference between the group's welfare when lobbying (i.e., W^o) net of contributions Co, minus the group's welfare when not lobbying (that is, W^{no}). Concerning lobbies' fixed organizational costs, for the time being, we make the simplifying assumption that $F^e > F^m = 0$.[17] However, we will envisage the possibility for the structure of organizational costs to be different across the two social groups in section 5. As we shall see, assuming null fixed costs for the materialist lobby implies that this lobby shall always

[16] In particular, Mitra (1999) precisely distinguishes individual and collective benefits from lobbying, and states the condition for collective lobbys' emergence.

[17] Dropping this assumption would not modify substantially our results. Nevertheless, assuming $F^m = 0$ makes our analysis of lobbies' emergence more straightforward, namely concerning the cases of full cultural hegemony, i.e., $\mu_s = 0$ and $\mu_s = 1$. However, a drawback of this hypothesis stems from the fact that it might make it interesting for agents to organize as (multiple) individual lobbies, rather than joining a collective interest group. Nevertheless, talking about individual citizens, collective lobbying configurations seem indeed more realistic. Moreover, citizens could still prefer a collective organized group (and sharing fixed costs), when organizational costs get arbitrarily small, but still different from zero.

get formed, even when the materialist group is very small. Indeed, this can be interpreted as a specific legacy of the materialist society.

Based on this assumption, and on (14), we can define the conditions for one lobby to emerge, starting from a situation in which no lobby exists, respectively for environmentalist and materialist citizens:

$$W_s^e\left(\widehat{t}_e\left(\mu_s\right)\right) - Co_s^e\left(\mu_s\right) - W_s^e\left(\widehat{t}_{em}\left(\mu_s\right)\right) > F^e \quad (15)$$

$$W_s^m\left(\widehat{t}_m\left(\mu_s\right)\right) - Co_s^m\left(\mu_s\right) - W_s^m\left(\widehat{t}_{em}\left(\mu_s\right)\right) > 0 \quad (16)$$

In condition (15), the net welfare gain for environmentalists is measured by the difference between the group's welfare when lobbying (i.e., with a tax rate $\widehat{t}_{e,s}$), net of contributions Co_s^e, minus the group's welfare under no lobbying (i.e., with a tax rate equal to $\widehat{t}_{em,s}$).[18] Concerning (16), the same reasoning applies.

In a similar vein, we can specify the conditions for the emergence of a second lobby, following a first one being created according to (15) or (16). In this case, for an environmentalist or a materialist second lobby to exist, the following conditions should be met:

$$W_s^e\left(\widehat{t}_{em}\left(\mu_s\right)\right) - Co_s^{e/m}\left(\mu_s\right) - W_s^e\left(\widehat{t}_m\left(\mu_s\right)\right) > F^e \quad (17)$$

$$W_s^m\left(\widehat{t}_{em}\left(\mu_s\right)\right) - Co_s^{m/e}\left(\mu_s\right) - W_s^m\left(\widehat{t}_e\left(\mu_s\right)\right) > 0 \quad (18)$$

According to condition (17), the net welfare gain for environmentalists to form a lobby (when materialists do) is measured by the difference between the group's welfare when lobbying (based on the two-group lobbying tax rate $\widehat{t}_{em,s}$), net of shared contributions $Co_s^{e/m}$, minus the group's welfare under a single materialist lobby entailing a tax rate $\widehat{t}_{m,s}$. A similar reasoning can be applied to (18).

In order to fully specify the net welfare conditions (15)-(18), we now have to turn to the analysis of equilibrium lobbies' contributions to the government. According to Grossman and Helpman (1994), in the special cases in which only one or two lobbies exist, equilibrium contributions by the organized groups can readily be obtained. More precisely, regarding one-lobby configurations, we can show that the equilibrium contribution $Co_s^i\left(\mu_s\right)$ by each lobby $i = e, m$ is the following:

$$Co_s^i\left(\mu_s\right) = a \cdot \left[W_s(\widehat{t}_{em}\left(\mu_s\right)) - W_s\left(\widehat{t}_i\left(\mu_s\right)\right)\right] \quad (19)$$

Because the tax schedule is the same with two-groups, or with no lobbying, $W_s(\widehat{t}_{em}\left(\mu_s\right))$ corresponds to the social welfare achieved without organized interest groups. Hence, the direct contribution by each lobby is

[18] We recall that, in the model, the tax schedule is shown to be the same without lobbying and with a "two lobbies" configuration, i.e., symmetric lobbying.

proportional to the welfare loss brought about by the emergence of such a lobby. In this case, the government does not get any surplus welfare with respect to the "no lobbying" situation. Indeed, direct contributions simply make the government participation to the lobbying deal possible. Hence, the single lobby captures the whole surplus generated by the deal, while it has to bear the weight of the entire amount contributed to the government.

Regarding two-lobby configurations, direct contributions can also be fully specified. In this case, the additional lobby should contribute an amount equal to the difference between the welfare that the rival and the government would achieve the second lobby not being active, and the welfare the two of them achieve in full equilibrium (i.e. without any lobby or, equivalently, with two active lobbies). More specifically, we can show that the equilibrium contribution $Co_s^{i/j}(\mu_s)$ by each lobby $i, j = e, m$ for $i \neq j$ is:

$$Co_s^{i/j}(\mu_s) = \left[{W_s}^j(\widehat{t}_{j,s}) + a \cdot W_s\left(\widehat{t}_{j,s}\right)\right] - \left[{W_s}^j(\widehat{t}_{em,s}) + a \cdot W_s\left(\widehat{t}_{em,s}\right)\right] \quad (20)$$

In other words, condition (20) tells us that the second lobby should pay contributions high enough to compensate its rival and the government for their joint welfare loss with respect to the status quo configuration, i.e. a single active lobby. Moreover, it is important to note that, with respect to the "one-lobby" case, the government is now able to capture the surplus generated by the lobby deal. In this case, this is made possible by the rivalry between the two organized groups. To see this simply, the government sets the same optimal tax as it would have set without lobbying but gains contributions. This is in line with findings of Grossman and Helpman (1994) that show that when a unique lobby is organized then it captures all the rent of the political relationship whereas when all the population is represented by lobbies, as is the case in the two lobbies situation, then the government gets the whole rent.

We are now in a position to obtain the equilibrium net welfare gains, respectively, for the "one-lobby" and "two-lobby" configurations. As for the former, we plug (19) into expressions (15) and(16), while, for the latter, we plug (20) into expressions (17) and(18).

Proposition 2 *Net welfare gains are inverted U-shaped functions of the share μ_s of environmentalist vs. materialist citizens, s.t. $NW^o(0) = NW^o(1) = 0$, $NW^o(\mu_s) > 0$ for all $0 < \mu_s < 1$, and show no discontinuities within the considered range of μ_s values.*

Proof. See Appendix A in which all net welfare functions are fully specified. ■

As stated in the above Proposition, the net welfare gain for each lobby depends on μ_s, i.e., the share of environmentalist vs. materialist citizens

within society, thus on the relative diffusion of cultural values. Indeed, in our model, these cultural features are assumed to change over time following a process of social change. This process stems from the socialization of ever new generations of citizens, which we shall investigate in section 4.

When $\mu_s = 0$ and $\mu_s = 1$, one single social group exists, and it has no interest in lobbying. As already mentioned for the case $\mu_s = 1$, the objective function of the government is simply U_e, hence the optimal policy set by the government is the one of environmentalists. In that case, any value of t is eligible since the polluting good is not consumed anymore. The same logic applies when $\mu_s = 0$: the society is only populated with materialists, hence the objective function of the government is U_m so it naturally peaks the optimal policy of materialists. Being organized even if it is free does not bring any additional benefit. Hence in our model, social and cultural hegemony by one group of citizens entails the collapse of lobbies.

On the contrary, for socially and culturally mixed societies, the NW gains from lobbying are positive. For intermediate values of μ_s, the NW functions start by increasing, and then decrease, as the share of environmentalists smoothly grows within the society. Let us explain this process with respect to the materialist group, first. In this case, the materialists' net welfare gain from lobbying increases as environmentalism spreads around society, up to a certain point. In fact, on the one hand, when environmentalist values start to be shared, the environmentalist group gets to improve its weight in the social welfare function. Then, this drives the government's tax policy against polluting goods, and motivate materialists to lobby. On the other hand, there exists a threshold value of μ_s behind which, materialists becoming a minority in society, they progressively loose grip and their collective gain from lobbying shrinks. Indeed, a similar reasoning applies to the environmentalist group' net welfare gain from their own lobbying.

Calibrations of the $NW_s^o(\mu_s)$ functions, based on parameters'set (13), are given in Figure 2, for different values of a and F^e. One should recall that, for $a = 8$, a single materialist lobby obtain from the government a downward sloping tax schedule, while the tax schedule is weakily upward sloping if $a = 15$. As shown in Figure 2, this does not modify the shape of the net welfare gains, over the range of feasible values for μ_s.

Based on the specific shape of net welfare functions, and our assumptions about fixed organizational costs, the materialist social group has critical advantages with respect to forming a lobby. Indeed, as Figure 2 shows, this is particularly important when society features polarized values, i.e., if either $\mu_s \to 0$ or $\mu_s \to 1$. As stated in proposition 2, in these cases, net welfare gains from lobbying always tend to zero for both social groups. Hence, because environmentalists face higher organizational costs, their lobby inevitably becomes non-viable. Coherently, whenever the society is predominantly materialist (as it has, historically, being the case) or predominantly

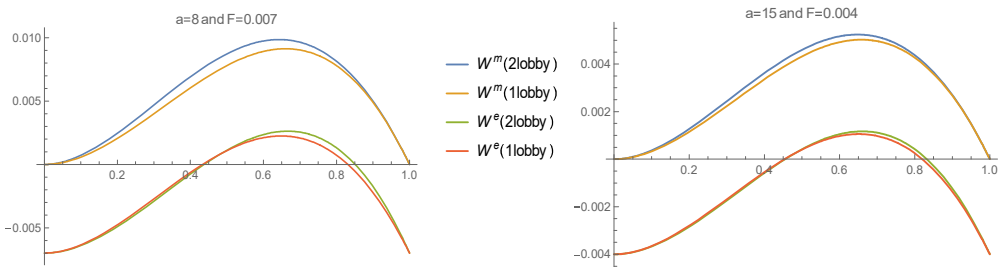

Figure 2: *NW* functions with two-group (lob2) vs one-group (lob1) lobbying.

environmentalist, then a single materialist lobby is the unique equilibrium configuration. Based on the above calibrations of the model, this configuration arises whenever $\mu_s < \mu_{low} \simeq 0.45$ or $\mu_s > \mu_{high} \simeq 0.83$.

Corollary 1 *Direct contributions are associated to non negative net welfare gains from lobbying under two equilibrium configurations, i.e., a two-lobby case, and a single lobby by materialist citizens. Because of the net welfare functions' shape and the assumption $F^e > F^m = 0$, the single environmentalist lobby configuration never happens.*

Given the above corollary, materialists always get organized in this society, in order to ensure a relief in fiscal pressure on polluting goods. This materialist lobby can act alone, or face an environmentalist lobby. Hence, in our model, the second lobby to emerge can be formed by environmentalist citizens. In order for this additional lobby to arise, environmentalists need to successfully organize themselves as an interest group, namely by paying fixed organizational costs F^e. The above calibrations point to the fact that the emergence of a two-lobby configuration requires society to attain a minimum threshold of cultural diversity equal to μ_{low}. Needless to say, the exact level of the threshold depends on exogenous parameters' values. In this respect, we want to stress the effects of social signalling, and the size of fixed organizational costs, which the environmentalist group should be able to pay in order to become organized. More precisely, the weaker the fixed costs or the stronger the social signalling channel, the lower the minimum threshold μ_{low}, and the easier for environmentalists to get organized.

Coherently, for intermediate parameters' values, such as $\mu_{high} > \mu_s > \mu_{low}$, the equilibrium configuration features two lobbies, one for each organized social group within society, i.e., a materialist and an environmentalist lobby. This suggests that, in order to achieve a more balanced structure of power and influence within the society, cultural diversity is indeed the key.

Corollary 2 *Our results regarding the equilibrium lobbying configurations are the following:*

$$\left\{ \begin{array}{lll} materialist\ lobby & if & \mu_s \leq \mu_{low}\ or\ \mu_s \geq \mu_{high} \\ two-lobby & if & \mu_{high} > \mu_s > \mu_{low} \\ no\ lobby & if & \mu_s = 0\ or\ \mu_s = 1 \end{array} \right\}$$

It is important to note that, for sufficiently high levels of F^e, the values of the two thresholds collapse, thus $\mu_{high} = \mu_{low}$, and the net welfare gain of environmentalist lobby is consistently non-positive. In this special case, a second lobby never arises, and the only possible lobbying configuration features a single materialist lobby for all $1 > \mu_s > 0$. We will study the implications of this configuration, for social change, in section 4.2. Finally, in section 5, we will consider the impact of alternative structures of organizational fixed costs, as well as shocks to social signalling. This will allow us to uncover some crucial factors that, in our model, entail the diffusion of environmentalism within post-materialist societies.

4 Dynamic framework: social change

In section 3.3, we have studied how a given structure of social values impacts on the equilibrium lobbying configuration. In this section, we take a step further and investigate the factors entailing over-time changes in values' distribution within society. More precisely, we analyze the way in which organized lobbies might contribute to shape the social fit of collective groups of citizens. In other words, with respect our previous results in section 3.3, we now explore the reverse effect of lobbying on cultural and social change.

Indeed, social change is a generational issue and is driven by children's socialization process. Based on Besley and Persson (2023) and Besley and Persson (2019), socialization is assumed to be influenced by parents' values as well as by parents' expectations as to the respective levels of well-being, for their children, from becoming a materialist vs. an environmentalist citizen.

4.1 The dynamics of cultural values

Following Besley and Persson (2019), we model the dynamics of value as a consequence of a process of socialization that primarily takes place within families. These are composed of two adults and two children. Whenever both parents share the same values, so will children too. However, in section 5, we will generalize the framework proposed by Besley and Persson (2019). More precisely, we will envisage spontaneous "mutations" for materialist citizens, i.e, the possibility that children from two materialist parents would, nevertheless, become environmentalists. We shall understand these mutations as a consequence stemming from the alarming situation of our planet, and from climate unbalances, which make young people change their minds and adopt greener values. As we will see, these spontaneous mutations give a better chance to environmentalism to spread around in society.

As Besley and Persson (2019), we assume that a proportion β of mating are assortative, thus parents certainly belong to the same type. However, a share $(1-\beta)$ of mating are random, and the probability of getting same-type parents is μ_s^2 for environmentalists while it is $(1-\mu_s)^2$ for materialists. Hence, the share of mixed parents is finally equal to $1-\mu_s^2-(1-\mu_s)^2 = 2\cdot\mu_s\cdot(1-\mu_s)$. In fact, this part of the adult population is the actual driving force of social change. Indeed, only mixed couple will get to choose how to socialize their children, in response to expected levels of well-being associated with them becoming of either type. In this case, if utilities evolve in a direction which is favorable to environmentalists, so will parents' efforts to socialize their children. Hence, the share of environmentalists will grow within the society. The reverse holds if materialistic utility levels improve *vis-à-vis* environmentalists' well-being.

From the model's point of view, let us assume, just as Besley and Persson (2019), that cultural fit solely depends on the utility differential $U_e(\mu_{s+1})-U_m(\mu_{s+1})$. These are the expression of individual utilities for citizens belonging to either types, i.e. sharing environmentalist vs. materialist values. Hence, parents are assumed to decide how to socialize their children based on the expected next period comparative individual welfare across types. Moreover, Besley and Persson (2019) introduce a family-specific shock υ distributed according to $G(*)$, symmetric around a zero mean, and with density $g(*)$. Adoption of environmentalist values happens if realizations of the random shock are such that $U_e(\mu_{s+1})-U_m(\mu_{s+1})>\upsilon>0$. By denoting $\Delta\mu_{s+1}=U_e(\mu_{s+1})-U_m(\mu_{s+1})$, the probability of such events is $G\left(\Delta\mu_{s+1}\right)-G(0)$, i.e. the probability of having both $\upsilon<\Delta\mu_{s+1}$ and $\upsilon>0$, with $G(0)=\frac{1}{2}$. The value of $G\left(\Delta\mu_{s+1}\right)$ also gives the share of environmentalists among those who have mixed parents.

To sum up, we can see that the value of μ_s changes over time according to the share of mixed parents out of non assortative mating (i.e., $2\cdot\mu_s\cdot(1-\mu_s)\cdot(1-\beta)$) multiplied by the probability of those parents socializing their own children as future environmentalist or materialist citizens, i.e., $G\left(\Delta\mu_{s+1}\right)-G(0)\gtrless 0$. Hence, we can finally write:

$$\mu_{s+1}-\mu_s = 2\cdot\mu_s\cdot(1-\mu_s)\cdot(1-\beta)\cdot\left[G\left(\Delta\mu_{s+1}\right)-\frac{1}{2}\right] \tag{21}$$

In this case, the dynamics of values depends on the sign of $\mu_{s+1}-\mu_s$, that is on $G\left(\Delta\mu_{s+1}\right)\gtrless\frac{1}{2}$. Because $G(*)$ is increasing in $\Delta\mu_{s+1}$ and $G(0)=\frac{1}{2}$, then $G\left(\Delta\mu_{s+1}\right)\gtrless G(0)$ if $\Delta\mu_{s+1}\gtrless 0$. Hence, we can simply focus on the sign of the utility differential in order to grasp the long-term evolution of values within the population. We refer to Besley and Persson (2019) for a complete analysis of the foundations of this dynamics. In particular, the authors prove that, in order to determine the sign of $\mu_{s+1}-\mu_s$, we can indeed rely on $\Delta\mu_s$, which avoid dealing with issues related to expectations.

In this case, based on Proposition 2 by Besley and Persson (2019), we can write:

$$\mu_{s+1} - \mu_s \simeq \frac{2 \cdot \mu_s \cdot (1-\mu_s) \cdot (1-\beta)}{1 - 2 \cdot \mu_s \cdot (1-\mu_s) \cdot (1-\beta) \cdot g\left(\Delta\mu_s\right) \cdot \Delta'_\mu} \cdot \left[G\left(\Delta\mu_s\right) - \frac{1}{2} \right] \tag{22}$$

As already seen, $\Delta\mu_s$ equals the utility differential $U_e(\mu_s) - U_m(\mu_s)$. Given (1) and (3), this differential can be written as follows:

$$\Delta\mu_s = \chi \cdot \varphi(\mu_s) - \theta \cdot (1-\mu_s) \cdot \widehat{c}\left(\widehat{t}_i\left(\mu_s\right)\right) - v\left(\widehat{t}_i\left(\mu_s\right)\right) \tag{23}$$

To sum up, the following process grasp the dynamics of social values within society:

$$\begin{array}{lll} \mu_{s+1} \geq \mu_s & \text{if} & \Delta\mu_s \geq 0 \\ \mu_{s+1} < \mu_s & \text{if} & \Delta\mu_s < 0 \end{array} \tag{24}$$

Based on (23), we can show that the lower the tax schedule $\widehat{t}_i\left(\mu_s\right)$, the smaller the value of $\Delta\mu_s$. The reason is that lower taxes entail an increase in the consumption of polluting goods $\widehat{c}\,(*)$ thus improving the indirect utility of materialist individuals $v\,(*)$. This clearly deteriorates both the welfare and the cultural fit of environmentalist citizens within society. More precisely, given (23), we can characterize the threshold value $\widetilde{\mu}$ such that, for $\mu_s > \widetilde{\mu}$, the society spontaneously converge to $\mu = 1$, while it converges to $\mu = 0$ whenever $\mu_s < \widetilde{\mu}$. This means that $\Delta\mu_s = 0$ if $\mu_s = \widetilde{\mu}$, and around $\widetilde{\mu}$ the sign of $\Delta\mu_s$ switches from negative to positive, and vice versa. This value $\widetilde{\mu}$ is the turning point in the dynamics of social change. By using implicit functions' properties, we can show by calculations that $\frac{d\,\widetilde{\mu}}{dt} = -\frac{\frac{\partial \Delta\mu_s}{\partial t}}{\frac{\partial \Delta\mu_s}{\partial \mu}} < 0$.

Hence, the threshold value $\widetilde{\mu}$ becomes higher, the lower the selected tax rate is. As a consequence, the value of $\widetilde{\mu}$ is the lowest under environmentalists lobbying. On the contrary, the value of $\widetilde{\mu}$ is the highest under materialist lobbying. Hence, the prevailing lobbying configuration impacts on the dynamics of values within society, and might influence the kind of cultural hegemony emerging out of the social change process.

4.2 Social change with a single materialist lobby

In this section, we investigate the determinants of social change, and focus on the impact of a single lobby by materialist citizens. Based on section 3.3, this configuration prevails as a lobbying equilibrium if fixed organizational costs for environmentalists are high enough for condition (17) not being satisfied, thus $\mu_{high} = \mu_{low}$. In this case, the net welfare gains for an environmentalist lobby are always negative. In order to enlighten the way in

which a unique materialist lobby shapes social change, we need to analyze the utility differential, i.e., $\Delta\mu_s = U_e(\mu_s) - U_m(\mu_s)$. In fact, the sign of this differential determines the direction of social change.

As a starting point, let us consider the case of a fully materialist society, that is $\mu_s = 0$. Based on corollary 2, a no-lobby solution prevails, and the tax schedule is given by $\widehat{t}_{em}(\mu_s)$ in (12). Given (23) and (1), we can then show that $\Delta\mu_s(0) < 0$. This means that, when μ_s equals 0, social change plays against environmentalists, and keeps society locked into an equilibrium configuration in which materialism is hegemonic from a cultural point of view.

However, what happens for values of μ_s arbitrarily close (but still not equal) to 0 ? In this case, based on corollary 2, a single materialist lobby solution emerges, and the tax schedule is given by $\widehat{t}_m(\mu_s)$ in (12). Once again, for $\mu_s \to 0$, $\lim \Delta\mu_s < 0$. Coherently, the corner solution $\mu_s = 0$ is locally stable. Two main factors help explaining this result. First, when materialists citizens are hegemonic, there is a single materialist lobby and the tax schedule is flat, which works against environmentalists. Moreover, the environmentalist citizens are too few in society to be able to take full advantage of the positive effects stemming from social respect.

Based on this result, a purely materialist society is a stable equilibrium for the dynamic process of social change, in our model. However, an endogenous cultural transition towards environmentalism might still take place. More precisely, this transition could happen if environmentalists experience greater chances to see their values spreading around, whenever their share increases within the society. Indeed, several effects are at play in our model, following an increase in the environmentalists' share. On the one hand, the network effect of social signalling becomes stronger, which might bear a positive impact of environmentalists' social fit. On the other hand, the tax rate under materialist lobby being given by $\widehat{t}_m(\mu_s)$ in (12), the tax schedule is indeed the flattest, and even downward sloping for $a < \frac{1+\lambda}{\theta}$ (see section 3.2). Consequently, $\Delta\mu_s$ remains consistently negative over relevant μ_s values. An exemple, which is coherent with this finding, is given by calibrations based on parameters' set (13), and presented in Figure 3.

At this point, in order to understand if environmentalism can emerge as social equilibrium, we shall look at the sign of the utility differential $\Delta\mu_s$ when $\mu_s = 1$. In this case, as shown in section 3.3, the net welfare gain from lobbying becomes zero, there are no more materialist citizens, and a no-lobby configuration prevails. Hence, the tax schedule is $t_{em}(\mu_s)$ in (12). Based on (1), we obtain that $\Delta\mu_s(1) > 0$, which is a similar result to Besley and Persson (2019).

However, what distinguishes our model is the process of social change for values of μ_s that are arbitrarily close (but still not equal) to 1. In our framework, materialist lobbying acts on the environmental tax schedule and makes

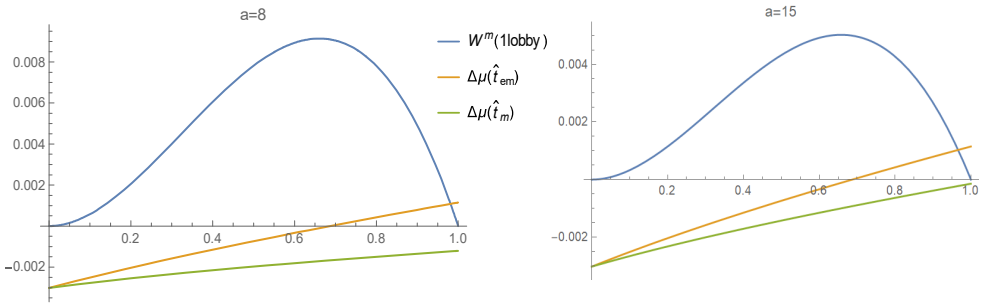

Figure 3: *NW* gain and $\Delta\mu_s$ with a materialist lobby

it flat. Hence, the dynamics of values is biased against environmentalism. More precisely, as shown in Appendix B, provided that environmentalist social signalling is not strong enough to offset the lack of fiscal pressure, for $\mu_s \to 1$ spontaneous social change consistently entails a decrease in the share of environmentalist values within society. To put it differently, contrary to Besley and Persson (2019), in our model, under a single materialist lobby, the environmentalist society is not a stable corner solution for social change. We are now in a position to sum up our main results in the following Proposition.

Proposition 3 *Given the process of social change (22) and (23), under a single materialist lobby, if* $\chi < \alpha - \ln[\frac{a}{1+a}(1+\theta+\lambda)]$*, only two corner solutions exist, namely* $\mu_s = 0$ *(i.e., materialists' cultural hegemony), which is stable, and* $\mu_s = 1$ *(i.e., environmentalists' cultural hegemony), which is unstable.*

Proof. See Appendix B. ■

Indeed, society is the victim of a sort of schizophrenia. Whenever environmentalist values spread around, they do not bear the expected consequences on taxes, but rather the opposite. Because of the dominant single materialist lobby, the tax schedule is $\widehat{t}_m(\mu_s)$ in (12), and the tax rate on polluting goods do not increase significantly, as the share and the weight of environmentalists grow within the society. Environmentalism is a source of social respect, but has no grip on policies. Hence, materialist lobbyers lead the dance as far as the level of green taxes is concerned. The government compensates them for loosing their share within the population, by granting them lower taxes on polluting goods in exchange for contributions.

The dynamics of social change is shown by calibrations in Figure 4, which depicts the over time trajectory of the environmentalists' share within society over a 200 periods' time span. A similar result can be obtained for $a = 15$. [19]

[19] For the purpose of calibrations, we use the dynamic process in (22). For $G(*)$ and

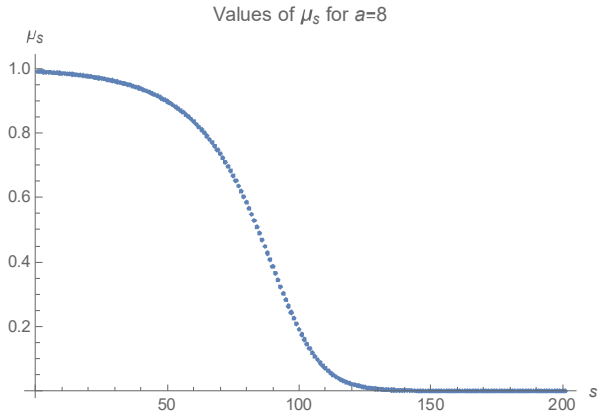

Figure 4: Social change with materialist lobbying

We consider this result as an illustration of a form of predatory lobbying. Because of predation, as long as materialist lobbying prevails, a green cultural transition can not succeed, and the unique stable social equilibrium features cultural hegemony by materialist values.

4.3 Social change with equilibrium lobbying configurations

In this section, we study the more general case in which the two social groups of citizens take decisions about getting together, and jointly forming a lobby. Indeed, because under materialistic lobbying, the process of social change is bound to erase their cultural values, environmentalists face a great incentive to get to organize as a collective interest group. Moreover, the emergence of a second environmentalist lobby leads to a change in the lobbying deal with the government, and a shift in the tax schedule. In this case, the relevant tax schedule in (12) is $\widehat{t}_{em}(\mu_s)$, which is steeper than $\widehat{t}_m(\mu_s)$, thus the tax rate sharply rises with the share of environmentalist citizens within society. Coherently, the rising tax pressure on polluting goods, together with social-signalling, help sustaining and promoting a social change that is directed toward green values.

Based on our previous results from Section 3.3, and notably Proposition 2, if environmentalists' fixed organizational costs are not too high, then $\mu_{high} \neq \mu_{low}$ and $\mu_{high} > \mu_s > \mu_{low}$. In this case, the equilibrium lobbying configurations change with the cultural composition of society, according

$g(*)$, we respectively consider the CDF and the PDF of a continuos uniform distribution over the interval {-1,+1}. Calibrations are ran with Mathematica software according to the following:

$\mu_{s+1} = \mu_s + coef(t_m) \cdot \left[CDF\left(\Delta\mu_s(t_m)\right) - \frac{1}{2}\right]$
with $coef(t_m) = \frac{2 \cdot \mu_s \cdot (1-\mu_s) \cdot (1-\beta)}{1-2 \cdot \mu_s \cdot (1-\mu_s) \cdot (1-\beta) \cdot PDF(\Delta\mu_s(t_m)) \cdot \Delta'_\mu(t_m)}$

to corollary 2. Moreover, the emergence of two lobbies, i.e., materialists and environmentalists, become possible. As we have seen in section 4.1, a two-lobby configuration entails a lower value of the threshold $\widetilde{\mu}$ such that, for $\mu_s > \widetilde{\mu}$, the utility differential becomes positive. Hence, once environmentalists get organized as a lobby, it becomes easier for pro-environmental values to spontaneously spread around, thanks to the process of social and cultural change.

Indeed, in a two-lobby equilibrium configuration, the government is more prone to respond to environmentalists' demands for green taxes, and the tax rate steeply increases in response to the rising weight of environmentalist citizens in society. Coherently, polluting consumption by materialists shrinks. As a consequence, the materialists' indirect utility decreases, which makes environmentalists more socially fit. In this case, $\Delta\mu_s > 0$ as long as the environmentalist lobby exists, and social change happens in a way which is favorable to the green cultural transition.

However, given the results in corollary 2, the two-lobby organization only takes place for $\mu_s < \mu_{high}$. In fact, when μ_s increases behond the threshold, the environmentalist lobby experiences a decrease in NW gains. For $\mu_s \geq \mu_{high}$, given the fixed organizational costs, the lobby is no more sustainable, and disappears. Coherently, for values of μ_s that are above μ_{high}, the organizational structure goes back to a single lobby by materialist citizens alone. As a matter of fact, for $\mu_s \geq \mu_{high}$, the model delivers the same results as in section 4.2, i.e. environmentalist cultural hegemony is not a stable solution for the process of social change. And again, spontaneous social change happens against environmentalists, and entails a decrease in the share of environmentalist values within the society, which prevents a full green cultural transition to take place. In this case, the structure of values goes back and forth in response to social and organizational change. As a consequence of the process, a periodic solution emerges, which is locally stable, featuring a culturally mixed society. The following Proposition states our main results in this respect.

Proposition 4 *Given the dynamic process of social change in (22) and (23), as well as the equilibrium lobbying configurations in corollary 2, there exist two corner solutions, i.e., $\mu_s = 0$ and $\mu_s = 1$, the former being locally stable, while the latter is globally unstable. Moreover, a locally stable periodic solution exists around μ_{high}, featuring a culturally mixed society.*

Proof. See Appendix B. ■

In other words, Proposition 4 states that society faces some sort of social and cultural "ceiling", around μ_{high}. The main reason for that ceiling to exist is that society experiences changes in the institutional structure of lobbies. In fact, a one-lobby configuration prevails for a polarized society, i.e., for $\mu_s \leq \mu_{low}$ and $\mu_s \geq \mu_{high}$, while a two-lobby configuration emerges

for a culturally mixed society s.t. $\mu_{high} > \mu_s > \mu_{low}$. While the equilibrium configuration switches between one and two lobbies, the lobbying deal with the government is modified: this affects the tax schedule, and the fiscal pressure that is put by the government on polluting goods.

Hence, we find that a crucial role is played by the process of institutional change, which impacts on the structure of lobbying and on the balance of power across the two social groups. This changing lobbying structure takes place as a consequence of social change, i.e., as a result of a new generation of citizens growing up and taking decisions about getting organized, or not, as a lobby. To sum up our results, if environmentalists do get organized, society can engage on a virtuous path towards a green cultural transition. However, this transition faces a ceiling, which is linked to declining NW gains from lobbying when approaching cultural hegemony, and entails a process of institutional change. In this case, institutional change yields the end of the environmentalist lobby, and a switch from a two-lobby to a single materialist lobby configuration, which indeed lowers the environmentalists social fit, and prevents a complete green cultural transition.

Indeed, we find that contrasting and opposite forces are at work within society. On the one hand, when $\mu_s < \mu_{high}$, the environmentalist lobby positively contributes to sustain and support a green cultural transition, by enforcing a lobbying deal entailing sharply rising taxes on polluting goods, thus leading to decreasing welfare for materialist consumers. As a consequence, μ_s increases through social change. On other hand, as soon as μ_s reaches values above the threshold μ_{high}, then the environmentalists' lobby looses its grip, and leave the path to a single materialists lobby, which operates in an opposite direction, i.e., reducing tax pressure on polluting goods and restoring materialists cultural and social fit.

As a consequence of these contrasting forces, the direction of social change switches from pro-environmentalist to pro-materialist around $\mu_s = \mu_{high}$. This is illustrated by the changing sign of $\Delta\mu_s$, going from positive ($\Delta\mu_s(t_{em})$) to negative ($\Delta\mu_s(t_m)$) when passing the threshold μ_{high}. Calibrations are presented in Figure 5 corresponding to the set (13) of parameters' values.

In this case, society converges to a mixed configuration of cultural values, featuring a "glass ceiling" for the environmentalist group. This periodic solution entails a swift from a balanced power two-lobby configuration (allowing environmentalists to become more socially fit, and their share to increase) back to a single materialist lobby. In this case, the environmentalists' relative power position weakens, and their share reverts to the starting level. Because of the existence of such a ceiling, the green cultural transition can not be completed.

In Figure 6, we present the results of calibrations concerning social

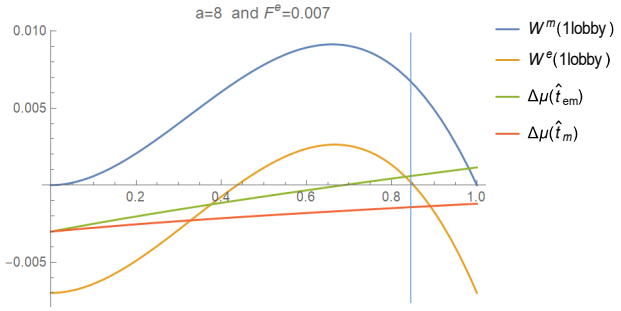

Figure 5: NW gain and $\Delta\mu_s$ with two lobbies

change, i.e., the over time trajectories of the share of environmentalist citizens within society.[20]

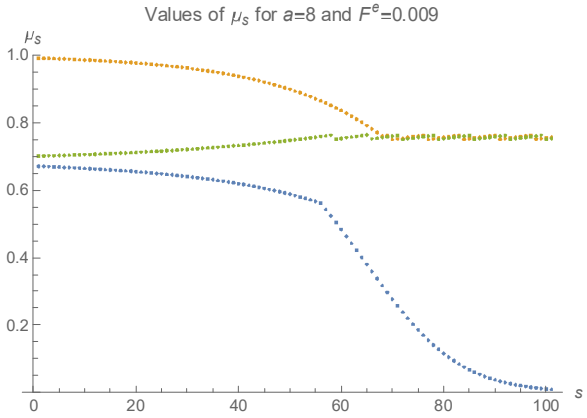

Figure 6: Social change with equilibrium lobbying configurations

The figure presents three over time trajectories, over a 100 periods' time span. With an initial value $\mu_0 \in [0.69, 0.99]$, the locally stable periodic solution emerges around $\mu_{high} = 0.75$. Moreover, for initial value $\mu_0 \in [0, 0.68]$, the locally stable corner solution $\mu_s = 0$ appears.

Finally, it is worth noting that a very similar picture of social change can be obtained with values $a = 15$ and $F^e = 0.004$, which clearly makes the point that our crucial result does not depend on the tax schedule being downward sloping under materialist lobbying.

[20] For $G(*)$ and $g(*)$ we consider respectively the CDF and PDF of a continuos uniform distribution over the interval {-1,+1}. Calibrations are ran with Mathematica software based on (22), hence: $\mu_{s+1} = \mu_s + If\left[condition\ (17), coef\left(t_{em}\right) \cdot \left[CDF\left(\Delta\mu_s\left(t_{em}\right)\right) - \frac{1}{2}\right],\ coef\left(t_m\right) \cdot \left[CDF\left(\Delta\mu_s\left(t_m\right)\right) - \frac{1}{2}\right]\right]$ with $coef(t_i) = \frac{2 \cdot \mu_s \cdot (1-\mu_s) \cdot (1-\beta)}{1 - 2 \cdot \mu_s \cdot (1-\mu_s) \cdot (1-\beta) \cdot PDF(\Delta\mu_s(t_i)) \cdot \Delta'_\mu(t_i)}$

5 Mutations, shocks, and environmentalism

In this section, we explore a few scenarios favoring a full cultural transition towards environmentalism within the society, i.e., changes in fixed organizational costs, shocks to social signalling, and spontaneous mutations.

First of all, the relative size of organizational costs is a crucial factor shaping the equilibrium lobby configuration. More precisely, in the paper, we have assumed higher fixed costs for the environmentalist lobby. This assumption entails the existence of two thresholds, i.e., $\mu_{low} \leq \mu_{high}$, which are particularly important for social change.

Coherently, by modifying the structure of fixed organizational costs, it is possible to affect the dynamic trajectory of values within society. In particular, lowering F^e entails, on the one hand, a higher μ_{high}, which allows to gradually break the glass ceiling faced by environmentalists. On the other hand, this also leads to a lower μ_{low}, thus favoring the early emergence of an environmentalist lobby, which might limit the scope for predatory lobbying by the materialist interest groups. An illustration is given by calibrations presented in Figure 7.

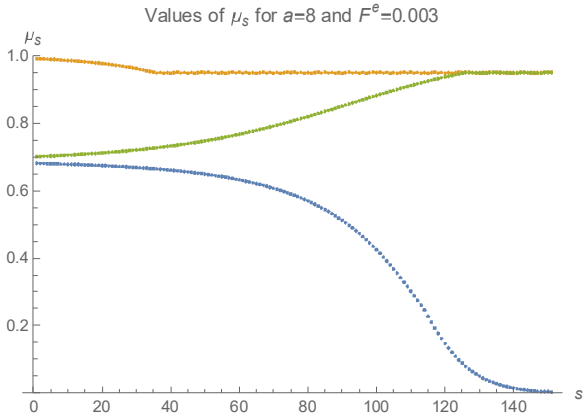

Figure 7: Social change with low environmentalists' fixed organizational costs

The figure presents the three over time trajectories, over a 150 periods' time span. For an initial $\mu_0 \in [0.69, 0.99]$, the locally stable periodic solution emerges around $\mu_{high} = 0.95$. Moreover, for initial value $\mu_0 \in [0, 0.68]$, the locally stable corner solution $\mu_s = 0$ appears. Hence, while lowering organizational costs, the value of μ_{high} is gradually shifted up towards 1. So, policies aiming at lowering F^e might indeed help breaking the ceiling experienced by environmentalists in the process of social change.

Nevertheless, lowering fixed organizational costs is enough to entail a green cultural transition. Indeed, if materialist values are initially largely

shared within the society, and materialist citizens widely present, then social change leads to society being caught in a cultural equilibrium with materialist hegemony. In Figure 7, this is the case for all trajectories starting from initial value $\mu_0 \in [0, 0.68]$. Indeed, because the social equilibrium corresponding to the corner solution $\mu_s = 0$ is stable, stronger counter-acting forces are required in order to enforce a global social change towards environmentalism.

More specifically, we can envisage two sorts of dynamic processes, which represent meaningful counter-acting forces with respect to materialism cultural hegemony, i.e., spontaneous mutations and shocks to social signalling.

In order to account for those forces in our model, we generalize our framework by introducing a probability of "mutations" concerning materialist parents and their children. In this case, environmental threats put pressure on materialist people and lead them to randomly "change their mind". To keep things simple, we consider that mutations occur according to an exogenous probability equal to $\delta \geqq 0$. This is the probability for materialist parents to eventually see their children randomly turning environmentalists. This probability applies to assortative mating of materialist couples, which represent a share $\beta \cdot (1 - \mu_s)$ of all mating, as well as to the share of materialist couples from non-assortative mating, i.e., $(1 - \beta) \cdot (1 - \mu_s)^2$. Based on these elements, the share of children, who become environmentalist by mutations, will be equal to $\delta \cdot \left[\beta \cdot (1 - \mu_s) + (1 - \beta) \cdot (1 - \mu_s)^2\right] = \delta \cdot (1 - \mu_s)^2$.

Coherently, we modify the dynamics of social change in (21) in order to account for mutations:

$$\mu_{s+1} - \mu_s = \delta \cdot (1 - \mu_s)^2 + 2 \cdot \mu_s \cdot (1 - \mu_s) \cdot (1 - \beta) \cdot \left[G\left(\Delta\mu_{s+1}\right) - \frac{1}{2}\right] \quad (25)$$

which finally yields:

$$\begin{aligned} & \mu_{s+1} - \mu_s \\ \simeq \quad & \delta \cdot (1 - \mu_s)^2 + \frac{2 \cdot \mu_s \cdot (1 - \mu_s) \cdot (1 - \beta)}{1 - 2 \cdot \mu_s \cdot (1 - \mu_s) \cdot (1 - \beta) \cdot g\left(\Delta\mu_s\right) \cdot \Delta'_\mu} \cdot \left[G\left(\Delta\mu_s\right) - \frac{1}{2}\right] \end{aligned} \quad (26)$$

First of all, mutations make impossible a full cultural hegemony by materialist citizens, because the corner solution $\mu_s = 0$ is no longer locally stable. Nevertheless, social change still converges to an almost materialist society, namely for low levels of the probability of mutations. Figure 8 provides calibration's results of social change trajectories when mutations occur with a low probability $\delta = 0.02$.

As Figure 8 shows, when the probability of mutation is low, two stable solutions emerge, the one featuring an almost materialist society, the other

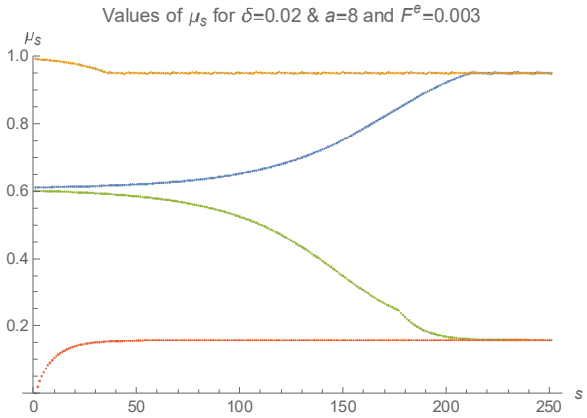

Figure 8: Social change with weak cultural mutations, and low environmentalists' fixed organizational cost

an almost environmentalist society. In order to illustrate this finding, the figure presents four over time trajectories of social change. For initial $\mu_0 \in [0.61, 0.99]$, a locally stable periodic solution emerges around $\mu_{high} = 0.94$. Moreover, for values of $\mu_0 \in [0, 0.6]$, a new locally stable solution appears at $\mu_s = 0.157$.

Next, we also consider a situation in which the probability of cultural mutations becomes high as a consequence, for instance, of dramatic environmental damages yielding strong concerns among the youth. Figure 9 provides trajectories of social change when mutations occur with a high probability $\delta = 0.1$.

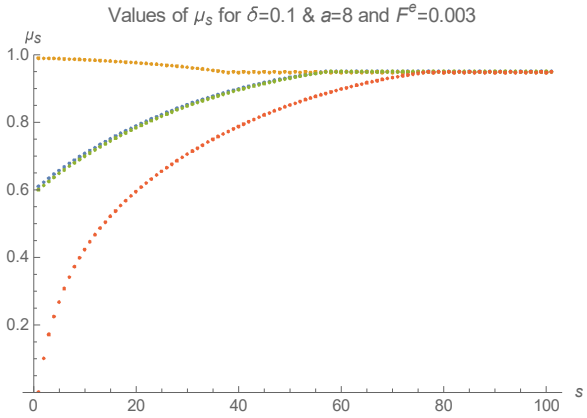

Figure 9: Social change with strong cultural mutations, and low environmentalists' fixed organizational cost

Figure 9 shows that, for sufficiently high values of the probability of

cultural mutations, spontaneous social change makes it possible for society to globally converge around $\mu_{high} = 0.94$, i.e. towards a predominantly environmentalist configuration of values.

While cultural mutations offer an interesting solution to the cultural trap in which society is kept by materialist lobbying, a stronger impact of social-signalling can also be elicited. In this case, stronger social respect *vis-à-vis* environmentalist citizens yields an impact on the utility differential (23). By improving the environmentalists' utility level, a stronger social respect favors their social fit. This may result in trajectories of social change that more easily converge towards an environmentalist cultural hegemony.

Figure 10 provides calibrations' results corresponding to a society in which social respect bears a high impact (with $\chi = 0.09$), and cultural mutations are set at a low level of $\delta = 0.02$. It is important to note that the selected value of the coefficient χ still fulfills the parametric condition stated in Proposition 3. Based on the figure, we can see that improving social signalling allows society to converge towards environmentalist cultural hegemony, from quite a large range of initial conditions. For initial $\mu_0 \in [0.36, 0.99]$, a locally stable periodic solution emerges around $\mu_{high} = 0.94$, while, for values of $\mu_0 \in [0, 0.35]$, a locally stable solution exists at $\mu_s = 0.17$. The former solution appears as particularly interesting. Indeed, it shows the possibility of a spontaneous cultural transition towards environmentalist values, starting from a mixed society in which environmentalist citizens are a minority but enjoy a high level of social respect.

Hence, the results depicted in Figure 10 suggest that policies aiming at improving the moral weight of ecological and environmentalist values can be effective in fostering a green cultural transition.

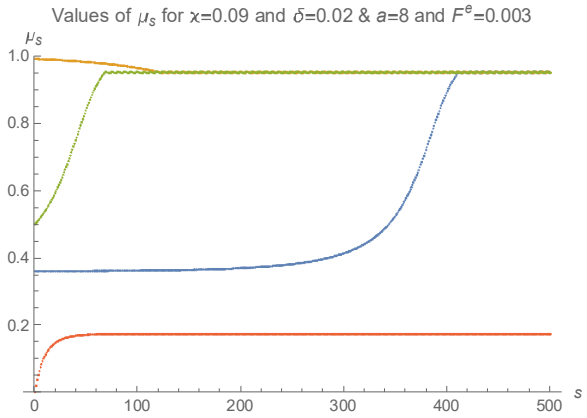

Figure 10: Social change with strong reputation, cultural mutations, and low environmentalists' fixed cost

6 Conclusion

In this paper, we have shown that the convergence of a society towards environmentalism is possible but hard to realize. This is not a surprise. In fact, despite the global increasing awareness around the world that acting strongly in favor of the environment is urgent, there are almost no countries where politics take effective actions to stop climate change. This could either be due to an insufficient spreading of environmentalist values within the society, and/or to a lack of relative power of environmentalists compared to materialists. Our goal was to study both possibilities and to see how they influence each other.

In order to do so, we have assumed that societies have historically started with materialists alone. Given this starting point, we have studied how it is nevertheless possible to see environmentalist values spreading within societies. The materialists have a strong advantage over environmentalists as they may freely organize into lobby. However, by investigating the endogenous lobbying organization of society, we have shown that an environmentalist lobby emerges, and takes more or less power, according to the fixed organizational costs that it faces.

In the paper, we have studied the effects of lobbying on the environmental policy set by the government, and its consequences on social change. In particular, we have shown that a unique materialist social equilibrium exists when materialist lobbying is dominant. However, a second social equilibrium (starring an important proportion of environmentalists) may emerge as a consequence of environmentalist citizens getting organized. Although this second equilibrium is locally stable, the threshold allowing dynamic convergence towards it might be very high. As a consequence, most initial social configurations dynamically evolve towards a materialist cultural hegemony, as our calibrations of the model show. Nevertheless, we are able to identify a few counteracting forces that may change the path of social evolution, and possibly facilitate convergence towards a cultural equilibrium more favorable to environmentalist values. These are also important policy implications of our model.

First, lowering fixed organizational costs faced by the environmentalist lobby is necessary to improve the effective pressure that this organized group can exert on the government. This allows to improve the social equilibrium featuring high environmental concerns. Social networks can help in this respect, under certain conditions. Second, favoring mutations in the population of materialists may mitigate the society's dead-end previously identified. Education, and civil campaigns, might be important ways to favor mutations. Finally, in order to accelerate the transition toward environmentalism, a positive shock on the social-signaling stemming from environmental values might also be necessary. Hence, increasing the moral dimension of environmental values is at stake.

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Appendix

A Ex-post equilibrium net welfare gains from lobbying: proof to Proposition 2

This proof stems from the properties of the NW functions that can be proved by calculations for each specification of the net welfare gains associated to the relevant lobbying configurations. These specifications are presented below. For all specifications, it can readily be show by calculations that $NW^o(0) = NW^o(1) = 0$, moreover $NW^o(\mu_s) > 0$ for all $0 < \mu_s < 1$. The functions show no discontinuities (and are differentiable), and therefore feature a single peak, within the considered range of μ_s values.

Concerning the single materialist lobby, by plugging (19) into (16), and then replacing tax schedules $\widehat{t}_{i,s}$ by their respective specifications (12), we can obtain the ex-post equilibrium net welfare gain from lobbying:

$$\begin{gathered} NW_s^m(\mu_s) = \\ (a+1)(1-\mu_s)\left[U_m\left(\widehat{t}_{m,s}\right) - U_m\left(\widehat{t}_{em,s}\right)\right] - a\cdot\mu_s\left[U_e\left(\widehat{t}_{em,s}\right) - U_e\left(\widehat{t}_{m,s}\right)\right] \\ = \frac{(1-\mu_s)\cdot\left((1+a)\cdot(1+\lambda+\theta\cdot\mu_s)\cdot\ln\left[\frac{(1+a)\cdot(1+\lambda+\theta\cdot\mu_s)}{(1+\lambda)\cdot(1-\mu_s)+a\cdot(1+\lambda+\theta\cdot\mu_s)}\right] - (1+\theta+\lambda)\cdot\mu_s\right)}{1+\lambda+\theta\cdot\mu_s} \end{gathered} \tag{27}$$

As already established in the proof to proposition 2, we can easily check that $NW_s^m(1) = NW_s^m(0) = 0$, and $NW_s^m(\mu_s) > 0$ for all $0 < \mu_s < 1$. Moreover, the function is inverted U-shaped, as expected.

In a similar vein, the ex-post equilibrium net welfare gain for one single environmentalist lobby is:

$$\begin{gathered} NW_s^e(\mu_s) = \\ = \mu_s\left[U_e\left(\widehat{t}_{e,s}\right) - U_e\left(\widehat{t}_{em,s}\right)\right] - Co_s^e(\mu_s) \\ = (a+1)\,\mu_s\left[U_e\left(\widehat{t}_{e,s}\right) - U_e\left(\widehat{t}_{em,s}\right)\right] - a\cdot(1-\mu_s)\left[U_m\left(\widehat{t}_{em,s}\right) - U_m\left(\widehat{t}_{e,s}\right)\right] \\ = \frac{(1-\mu_s)\cdot\left(-a\cdot(1+\lambda+\theta\cdot\mu_s)\cdot\ln\left[1+\frac{(1+\lambda+\theta)\cdot\mu_s}{a\cdot(1+\lambda+\theta\cdot\mu_s)}\right] + (1+\theta+\lambda)\cdot\mu_s\right)}{1+\lambda+\theta\cdot\mu_s} \end{gathered}$$

Concerning the two-lobby configuration, by plugging (20) into (17), and then replacing tax schedules $\widehat{t}_{i,s}$ by their respective specifications (12), we can obtain the ex-post equilibrium net welfare gain for the environmentalist lobby:

$$\begin{gathered} NW_s^{e/m}(\mu_s) = \\ = \mu_s\cdot\left[U_e\left(\widehat{t}_{em,s}\right) - U_e\left(\widehat{t}_{m,s}\right)\right] - Co_s^{e/m}(\mu_s) \\ = (a+1)\cdot\left[W_s\left(\widehat{t}_{em,s}\right) - W_s\left(\widehat{t}_{m,s}\right)\right] \\ = (a+1)(1-\mu_s)\left(-\frac{(1+\lambda+\theta)\cdot\mu_s}{(1+\lambda+\theta)\cdot\mu_s + a\cdot(1+\lambda+\theta\cdot\mu_s)} + \ln\left[1+\frac{(1+\lambda+\theta)\cdot\mu_s}{a\cdot(1+\lambda+\theta\cdot\mu_s)}\right]\right) \end{gathered} \tag{28}$$

Again, as stated in the proof to proposition 2, we can show by calculations that $NW_s^{e/m}(1) = NW_s^{e/m}(0) = 0$, and $NW_s^{e/m}(\mu_s) > 0$ for all $0 < \mu_s < 1$.

Finally, the ex-post equilibrium net welfare gain for the materialist lobby, in the two-lobby configuration, is:

$$\begin{gathered} NW_s^{m/e}(\mu_s) = \\ = (1-\mu_s)\left[U_m\left(\widehat{t}_{em,s}\right) - U_m\left(\widehat{t}_{e,s}\right)\right] - Co_s^{m/e}(\mu_s) \\ = (a+1)\cdot\left[W_s\left(\widehat{t}_{em,s}\right) - W_s\left(\widehat{t}_{e,s}\right)\right] \\ = (a+1)(1-\mu_s)\left(\frac{(1+\lambda+\theta)\cdot\mu_s}{(1+\lambda)\cdot(1-\mu_s)+a\cdot(1+\lambda+\theta\cdot\mu_s)} - \ln\left[\frac{(1+a)\cdot(1+\lambda+\theta\cdot\mu_s)}{(1+\lambda)\cdot(1-\mu_s)+a\cdot(1+\lambda+\theta\cdot\mu_s)}\right]\right) \end{gathered}$$

B Social change: proof to Propositions 3 and 4

The proof to Proposition 3 can be provided on the ground of the analysis of (23) in conjunction with results presented in corollary 2. To sum up, for $\mu_s = 0$ there are no lobby, and, given (23) and (1), we can prove that:

$$\begin{aligned} \Delta\mu_s(0) &= \chi\cdot\varphi(0) - \theta\cdot\widehat{c}\left(t_{em}(0)\right) - v\left(\widehat{t}_{em}(0)\right) \\ &= -\theta\cdot\frac{1}{1+\lambda} - \alpha + \ln[1+\lambda] < 0 \end{aligned}$$

For $\mu_s \to 0$, there is one single materialist lobby. In this case, based on corollary 2, a single materialist lobby solution emerges, and the tax schedule is given by $\widehat{t}_m(\mu_s)$ in (12). Hence, for $\mu_s \to 0$ equation (23) becomes:

$$\begin{aligned} \lim\Delta\mu_s &= \lim\left[\chi\cdot\varphi(\mu_s) - \theta\cdot(1-\mu_s)\cdot\widehat{c}\left(\widehat{t}_m(\mu_s)\right) - v\left(\widehat{t}_m(\mu_s)\right)\right] \\ &= -\theta\cdot\frac{1}{1+\lambda} - \alpha + \ln[1+\lambda] < 0 \end{aligned}$$

Therefore, the corner solution $\mu_s = 0$ is (locally) stable. To qualify this point, we shall consider the derivative of $\Delta\mu_s$ with respect to μ_s. In this case, we obtain:

$$\Delta_\mu^{'} = \chi\cdot\varphi_\mu^{'} - \theta\cdot\widehat{c}_t^{'}\cdot\widehat{t}_{i_\mu}^{'} + \theta\cdot\widehat{c}(t_i) - \widehat{v}_t^{'}\cdot\widehat{t}_{i_\mu}^{'} \tag{29}$$

Based on the analysis in section 3.1, we know that $\varphi_\mu^{'} > 0$, $\widehat{c}_t^{'} < 0$, $\widehat{v}_t^{'} < 0$. The tax schedule with a materialist lobby is given by $\widehat{t}_m(\mu_s)$ in (12), that is the flattest, and even downward sloping for $a < \frac{1+\lambda}{\theta}$ (see section 3.2). Consequently, $\Delta_\mu^{'}$ is only weakly positive in our model, as long as materialist lobbying prevails. Hence, $\Delta\mu_s$ is consistently negative over relevant μ_s values.

However, a second corner solution exists for $\mu_s = 1$, such that $\Delta\mu_s(1) > 0$. In this case, as seen in section 3.3, the net welfare gain from lobbying

becomes zero, there are no more materialist citizens, and a no-lobby configuration prevails. Hence, the tax schedule is $t_{em}(\mu_s)$ in (12). Based on (1), we obtain

$$\begin{aligned}\Delta\mu_s &= \chi\cdot\varphi(1) - v\left(\widehat{t}_{em}(1)\right) = \chi - v\left(\widehat{t}_{em}(1)\right)\\ &= \chi - \alpha + \ln[1+\theta+\lambda] > 0\end{aligned}$$

This solution is locally instable. In order to understand this point, we can look at the utility differential when $\mu_s \to 1$. We obtain:

$$\lim\Delta\mu_s = \lim\left[\chi\cdot\varphi(\mu_s) - \theta\cdot(1-\mu_s)\cdot\widehat{c}\left(\widehat{t}_m(\mu_s)\right) - v\left(\widehat{t}_m(\mu_s)\right)\right] \quad (30)$$

$$= \chi - \left(\alpha - \ln\left[\frac{a}{1+a}\cdot(1+\lambda+\theta)\right]\right) \quad (31)$$

Based on (2), we know that $\alpha - \ln\left[\frac{a}{1+a}(1+\theta+\lambda)\right] > 0$. Coherently, for $\mu_s \to 1$ we find:

$$\Delta\mu_s < 0 \quad if \quad \chi < \alpha - \ln[\tfrac{a}{1+a}(1+\theta+\lambda)] \quad (32)$$

Hence, in the absence of significant fiscal pressure, if social signalling alone is not high enough, then the environmentalist corner solution is not stable.

We now turn to the proof to Proposition 4. The proof to the first part of the Proposition is the same as for the previous Proposition 3.

Concerning the third periodic solution, based on corollary 2, with $\mu_{high} > \mu_s > \mu_{low}$, the equilibrium lobbying configuration is two organized interest groups. Hence, a discontinuity occurs in $\mu_s = \mu_{high}$. We can prove that $\Delta\mu_s > 0$ for $\mu_s < \mu_{high}$, while $\Delta\mu_s < 0$ for $\mu_s \geq \mu_{high}$. More precisely, $\widehat{t}'_{i_\mu} > 0$ in (29), and the utility differential (23) significantly improves as the share of environmentalists μ_s rises, eventually becoming positive. In fact, with a two-lobby configuration, for μ_s increasing toward 1, given the tax schedule $\widehat{t}_{em}(\mu_s)$ from (12), the limit value of $\Delta\mu_s$ is:[21]

$$\begin{aligned}\lim\Delta\mu_s &= \chi\cdot\varphi(1) - v\left(\widehat{t}_{em}(1)\right)\\ &= \chi - \alpha + \ln[1+\theta+\lambda] > 0\end{aligned}$$

However, for $\mu_s \geq \mu_{high}$, the organizational structure goes back to a single materialistic lobby and the $\mu_s = 1$ solution is no longer stable. While society goes back to a single materialistic lobby, the tax schedule switches

[21] Hence, the corner solution supporting environmentalist cultural hegemony would indeed be stable, should a two-lobby configuration always exist.

back to a flatter slope, and fiscal pressure drops. Hence, environmentalists loose their grip, and their share shrinks. But then again, by lowering μ_s, social change favor the re-emergence of a two-lobby structure entailing a stronger fiscal pressure on polluting goods. This brings again better chances to environmentalists to benefit from social change. As a consequence of this process, a periodic solution emerges, which is locally stable, featuring a culturally mixed society.