Moving to Greener Societies: Moral Motivation and Green Behaviour

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Abstract

This paper intends to provide an alternative explanation of why societies behave differently from an environmental point of view. To do so, I use a Kantian moral approach at a microeconomic level. Under this premise, I show that two identical societies (according to income and political system) might follow different paths with respect to their "green" behaviour. Additionally, I identify tipping points that could nudge a society from a polluting behaviour to a green one. I find that environmental perception as well as how governments are elected can be important factors in this shift.

JEL Classification: Q50, D64, H41, C62

Keywords: Environmental motivation, Kantian morale, green behaviour, tipping points.

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1 Introduction

This paper aims to provide an alternative explanation of why countries behave differently with respect to the environment, even though they might be quite similar from an economic development point of view. To do so, I use a simple micro-founded model in which individuals derive utility from their own well-being as well as from social welfare. The latter utility comes from the idea that individuals derive satisfaction from doing 'the right thing' (at least, up to some degree) or, as Immanuel Kant stated, from behaving according to the imperative principle. Being or acting green could be in line with one of such imperative principles. Using these concepts plus a simple political framework, I show that two equivalent societies (with the same income, political system, etc.) can reach two different environmental behaviour equilibria. I also locate the means of nudging a society from one equilibria to another.

Different theories have been developed in order to explain, to some extent, the dissimilarity of green behaviour among similar countries. One set of theories revolves around a country's level of development. For example, Environmental Kuznets Curves (EKC) relate a country's environmental behaviour to its income level, revealing an inverted U-shaped relationship between them.(1) The drawback of such an approach is that it cannot explain the dissimilar behaviour (for example with respect to CO_2 emissions per capita) among countries with similar income levels, like the divergence between the USA, Canada, and Australia and their European counterparts like Sweden, Norway, and Finland.

The literature also addresses the determinants of green behaviour by comparing political systems. Persson et al. (2000) [21] used a theoretical model to show that presidential regimes should produce an under-provision of public goods (e.g. a cleaner environment). On the other hand, Bernauer and Koubi (2004 [2]) found the opposite result. Using an econometric study, they provide evidence that presidential democracies provide more public goods than do parliamentarian democracies. More recently, Saha (Saha (2007) [26]) tested the previous hypotheses empirically. She finds that the electoral system has no effect on any of the environmental public good supply indicators and that the nature of the political regime has no significant impact either. Taken together, these results present neither a clear nor a consistent view of how political systems might influence a society's green behaviour.

(1)The EKC is similar to a traditional Kuznets curve. As a country gets richer (and more developed) it begins to pollute more (as measured on a per capita basis). After reaching a certain development level, society begins to designate more importance to the environment and therefore starts to pollute less as it becomes richer. Hence, we observe an inverted U-shape for the relationship between pollution and income per capita.

Therefore, I propose a different approach that uses the concept of 'moral gain'. We observe green actions which cannot be explained with a purely homo-economic theory. If individuals only abided by homo-economic principles, there would be no incentive for them to contribute to maintaining a good environment since the gain for this action would be negligible. Moral gains have already been discussed in the literature, starting with the idea of 'warm-glow giving' (Andreoni (1990) [1]) in which the sole act of giving provides utility to the agent. This notion has been further developed by Nyborg and Rege (2003) [19] and Nyborg et al. (2006) [18]. The former study provides a comprehensive 'summary' of different types of moral motivations (altruism models, social norm models, fairness models, models of commitment and the cognitive evaluation theory), although it focuses on how these different types of moral motivations can crowd out private contributions. Nyborg et al. (2006) presents a model using peer pressure, in which societies become polarized. In other words, a society can be completely green (when everyone conserves the environment) or completely grey (when everyone chooses to pollute). Such an outcome, however, has not been observed in reality.

I depart from the previous models proposing the following: People are diverse and behave, up to some degree, according to a Kantian imperative. That is, individuals try to do 'the right thing'. Therefore, though an individual might conform to a (private or 'selfish') homo-economic behaviour, they are also concerned about public well-being, as with the Homo Politicus of Nyborg (2000) [17].(2) In other words, the agent takes into account what would or should be his behaviour with the premise that everybody will do as he does, as also modelled in Laffont (1975) [14]. Therefore, this type of behaviour internalizes the negative impact of a polluting conduct in society. The use of the Kantian imperative is not a novel idea in green behaviour. It has been already explored by Laffont [14], Brekke et al (2009) [4] and Wirl (2011) [28], among others. Moreover, this feature is in line with some empirical findings as in the case of Leiserowitz (2006) [16], who finds that *"egalitarian-value based"* individuals (similar to the Kantian morale) stand for green policies.

In my model, the heterogeneity in people' behaviour arises from how 'Kantian' they are, which makes people act differently with respect to environment protection. Some individuals are more environmentally concerned than others. I thus consider these individuals as Kantian. To be Kantian means that they will follow a given rule as if everyone

(2)Nyborg talks about Homo Politicus agents: individuals that regard themselves as ethical observers or citizens, judging matters from society's point of view. She uses two types of Homo Politicus in her model: a Homo Politicus with *shared responsibility* and another with *sole responsibility*. The first type of Homo Politicus assumes that everybody contributes to social welfare, whereas in the second case the agent disregards altogether the possibility that others might bear the cost. I use a model closer to the first case.

else is also following that same rule. More precisely, they will behave as if answering the following question: *"Which general rule of action should I follow to maximize social welfare, as I perceive it, given that everyone acts according to the same general rule?"*(3) In doing so, their green behaviour might depend on the current state of environment or, at least, how they perceive it to be. For example, the implications of contaminating the environment when it is already quite polluted are quite different from the case where the environment is clean.

As we can see, this is an evolving process. Individuals' awareness depends on the perception of environmental quality (or pollution). Changes in the environmental state and/or a correction to perceptions can cause awareness to vary. At the same time, public decisions are taken by governments. Therefore, a government may be willing to implement a green policy if it has the enough support in its constituency, like Sweden in the late 90's.(4) Consequently, I introduce a simple political mechanism into the model. The government in power will put in place a green (or greener) policy if the people demand it. I assume that if individuals behave green, they are also prone to have a green policy in place. This is in line with what was observed in Germany by Comin and Rode (2013) [6], who show that when people behaved in a greener way, green parties received more votes at elections.

This type of modelling is in line with some phenomena observed in real life. A worse state of the environment, which is expressed by Mother Nature with more frequent and severe climate events, triggers concern. This fact has been comprehensively studied by different surveys (as in Gallup and GlobeScan among others: [22] [23] [27]) and verified using econometric techniques by Krosnick et al. (2006) [12] and Zahran et al. (2006) [29]. An overall analysis was then performed by Lee et al. (2013) [15] who show that, after major climate events, individuals' environmental awareness and concern rises, typically in the short term only. As an illustrative example, after superstorm Sandy hit New York City, President Obama said: *"We must do more to combat climate change ... Now, it's true that no single event makes a trend. But the fact is, the 12 hottest years on record have all come in the last 15. Heat waves, droughts, wildfires and floods, all are now more frequent and more intense."*(5) Although this statement does not mean that proper environmental behaviour will materialise immediately, it shows that awareness of climate issues has reached a significant segment of the population and has been acknowledged by those in power.

Combining these elements, namely different types of people with regard to their envi-

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(3)I come back to the Kantian imperative with a more detailed explanation on page 8.

(4)Sweden was the first country to introduce a carbon tax in 1991, and they have been increasing it as time has gone by. They are even aiming higher and "point out how to achieve the 2050 vision of zero net GHG emissions" in their Climate Roadmap. (Energy Policies of IEA Countries, Sweden, 2013 review).

(5)President Obama at the State of the Union Address. February 12th, 2013.

ronmental behaviour (their Kantian 'structure'), environmental-induced awareness, green action and a simple political system, I find that two equivalent societies can reach two different environmental behaviour equilibria, even though they share the same structural characteristics (with respect to income, political system, etc). I also identify the possibility of switching from one equilibria to another. In other words, there is a tipping point at which a society that is not behaving in an environmentally friendly manner can switch to green behaviour. The mechanics have to do with the idea that having a more polluted environment makes people more aware, triggering green behaviour. But it may be the case that this is not enough to switch the political praxis into a green one, and we could be left with a grey society. But there could also be the case where the awareness levels and behaviour are such that a green(er) government gets elected, starting a changing process and tipping the system.

The existence of a tipping point raises an important question: Namely, how can a society be swayed from grey to green? To shed more light on the mechanisms behind this switch, I analyse the influence of two factors, individuals' perception of pollution and the existing political system. In the long run, a shock to the perception of pollution (such that individuals become more aware of or concerned with environmental issues) is an effective mechanism to induce tipping. Moreover, a political framework in which coalitions are more likely to exist eases the shift from a grey to green society. This has to do with the fact that a more 'continuous' political spectrum allows a society to shift to a relatively greener government and, from there, to greener and greener governments in a cascading process. Applied to a government level, this cascading idea is similar to one developed by Kuran (1991) [13].(6)

To finalise the model, I add another psychological ingredient. So far, moral motivation is based on the agent's personal motivation, the Kantian morale. But other types of motivations may exist. For example, *peer effects* or *social approval* can act as a secondary motivator, as with the case of Nyborg et al. (2006) [18]. But in this case, their modelling is structurally different to the present one, yielding a completely polarized society. In contrast, incorporating this concept into the model reveals that the previous results hold and, in fact, an 'ideological' peer effect(7) makes the transition from a grey to green society a more difficult task to achieve. This comes from the notion that if the society is primarily

(6)Kuran talks about the collapse of Eastern Europe's communist regimes. He divides the society into 10 types of people, from those who are more in favour of a communist government, to those completely opposed to it. He shows that if some sort of threshold is crossed, protests can begin and this can encourage others initially less prone to go against the incumbent regime to start protesting, too. This process can lead to a cascading effect, which can in turn produce the collapse of the whole regime.

(7)This means that green people prefer that others are green, and grey people prefer that others are grey. Of course, it might be the case that being grey is always considered 'bad', even for grey people, as for example with smoking.

grey, in order to behave green the agent will have to bear its economic cost ***plus*** the new peer pressure 'cost', making the shift harder to accomplish.

The paper is structured as follows: First, Section 2 presents the model and its main features. Section 3 shows possible tipping points and demonstrates how the system can be nudged. Section 4 introduces the concept of social approval as a psychological driver of behaviour. Section 5 concludes and presents a brief discussion of the model.

2 The Model

The people

I consider that people care about their own utility and about social utility, as mentioned in the Introduction. Because individuals can have different ***attitudes*** for social well-being, this causes heterogeneity among agents. Therefore we can write each agent's utility as:

$$U(\cdot) = (1-\alpha)\, u_p + \alpha\, u_s \tag{2.1}$$

where u_p and u_s are the private and social utility respectively. The parameter α ($0 \leq \alpha \leq 1$) represents how homo-economic ($\alpha \to 0$) or Kantian ($\alpha \to 1$) the person is, hence his ***attitude***. An attitude can be thought of as an inherited trait that comes from cultural background and education. In other words, it relates to how much the agent cares about social well-being. Hence $\alpha = 0$ means that the agent does not care at all for the rest of the society, whereas $\alpha = 1$ means that an agent cares the most. Moreover, the society is composed of a continuum of people, each one matching a value of α in a biunivocal correspondence where α has some distribution f_α.[8]

Both u_p and u_s are constructed in the same way. They have a consumption part $u(\cdot)$ and a damage part $d(p_t(\cdot))$:

$$u_i = u(\cdot) - d(p_t(\cdot)) \tag{2.2}$$

The first part, $u(\cdot)$, is the classic consumption utility with $u' > 0$ and $u'' < 0$. The damage term $d(p_t(\cdot))$ also has its classic properties of $d' \geq 0$, $d'' > 0$ and $d'(0) = 0$, where $p_t(\cdot)$ denotes the pollution level at time t. I come back to these functions in the following pages.

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[8] As will be made clear in the following pages, the distribution of α will not change the main results but assuming a uniform distribution will certainly ease the subsequent calculations and simulations. The latter will be performed using a uniform distribution. On the other hand, different distributions will simply change the place of the tipping point and the conditions needed to tip, as in Kuran (1991) [13].

Goods and Pollution

In this simple framework, each person can either buy green products (x) or grey products (y). The only difference between these goods is that the green one does not pollute, whereas the grey one does. In other words, from a consumption point of view, they are perfect substitutes. The drawback of the green product is that it is more expensive than its grey counterpart.[9] I assign a normalized price of 1 to the grey good and a price of $(1+\rho)$ to the green one. Therefore the value of ρ represents the extra amount (with respect to the whole original price) to be paid for a green product. Since the grey product pollutes, I also denote by γ the impact on the environment of the consumption (production) of this type of product. For simplicity, the agent will only choose one or the other, not a mix. The agent's income is also normalized to 1.

Hence the agent can be a 'grey' consumer, $(x, y) = (0, 1)$, or a 'green' consumer, $(x, y) = (\frac{1}{1+\rho}, 0)$. The pollution equation will be the standard one:

$$p_t = (1-\delta)p_{t-1} + \gamma \cdot y_t^s \tag{2.3}$$

where p_t is the pollution level at time t, δ is the natural decay of pollution level (due to natural absorption), and y_t^s is the *society's* grey consumption at time t, which is just the sum of grey consumption by all agents. I will come back to this term in the following pages.

Public Concern

I will call 'public concern' the part of the utility function which pertains to social welfare. Each agent is weighted by the parameter α which captures the degree to which he/she is concerned about public well-being. In order to model the public concern and the impacts of this concern on the agent's behaviour, I use the 'Kantian' morale as previously described. More precisely, the agent will consider u_s as if everyone else were behaving as he is. This does not mean that the agent is expecting that everybody will behave as he does. However, this allows us to mimic the decision process by modelling the utility from doing the right thing, which is in line with the Kantian idea. In other words, this part of the utility function is modelled as if the agent thinks that everybody is behaving as he does in order to make a decision about how to behave. Strictly speaking, this is not what Kant meant with his Categorical Imperative. His was not an heteronomous ethic. In this sense, the present formulation is not categorical, autonomous or independent of external influence, but on the contrary, depends on the environment's quality. On

[9] If there were a green good which had the same price as its grey counterpart, or if it were cheaper, agents would automatically choose that good instead of the grey one for purely economic reasons. If that were the case, we could recalculate the pollution produced by a new representative grey good and return to the set-up presented here.

the other hand, my formulation is in line with the one used by Laffont [14], which borrows the idea of choosing the good (ethical) rule when assuming that everybody behaves as I do - hence, the (non-precise) name of *'Kantian'* morale.

Regarding pollution, the level considered by the agent is the (estimated) pollution level p_t^e. This, in turn, depends on two factors: the perceived (past) pollution level, p_{t-1}^p, and the assumed emissions. At this point I assume that the agent has perfect information about the past pollution level, $p_{t-1}^p = p_{t-1}$. Recalling the pollution equation (2.3) we get the following relationship:

$$p_t^e(y^s) = (1-\delta)p_{t-1}^p + \gamma \cdot y^s \tag{2.4}$$

Now I return to the private and social utility functions. For u_p, the agent understands that he is atomistic with respect to the society, and hence he knows that his contamination is negligible with respect to the total emissions. This translates to a damage term $d(p_t(y))$ that does not vary with his individual decision y, but actually depends only on the society's behaviour y^s. Since this term does not vary with the agent's decision, I drop it from the following equations.

On the other hand, u_s is the social utility taken into account by the agent when using a Kantian view. In other words, the agent considers that everyone behaves as he does, implying that society's emissions y^s will follow his choice y, as well as x^s with x. Putting all of the pieces together and rewriting the previous equations, we get:

$$u_p = u(x,y) \qquad \text{and} \qquad u_s = u(x,y) - d(p_t^e(y)) \tag{2.5}$$

Finally, we can plug these results into the agent's utility function 2.1, arriving at:[10]

$$U(y) = (1-\alpha) \cdot [u(x,y)] \, + \, \alpha \cdot [u(x,y) - d(p_t^e(y))]$$

$$U(y) = u(x,y) - \alpha \cdot d(p_t^e(y)) \tag{2.6}$$

$$U(y) = u(x,y) - \alpha \cdot d[(1-\delta)p_{t-1} + \gamma \cdot y] \tag{2.7}$$

This formulation is in harmony with the standard representation of green behaviour. Since a purely homo-economic approach cannot explain this type of behaviour, we must consider a moral motivation, as stated in the Introduction. Green people behave green because they think it is the right thing to do, not because it is in their best economic interest. But what is the right thing to do in a framework like this one? To tackle this question, I have used the ideas of Immanuel Kant. In his search of what was 'good' and 'bad', he came with the idea that a good conduct could be one that could be tested as a maxim rule, one in which everyone would be following it, known as the Categorical Imperative

[10] Recall that the pair (x,y) can be either $(0,1)$ or $(\frac{1}{1+\rho}, 0)$.

(Kant (1785) [11]). If this rule makes the society better off, then it is a good rule to follow, meaning that following it makes us good people. In order to use this idea, for the present formulation this dictum can be translated into: *Which general rule of action should I follow to maximize social welfare, as I perceive it, given that everyone acts according to the same general rule?*(11)(12) We can see now that this approach fits the model quite well. The agent is considering the social well-being u_s in his personal utility function. If he thinks that everyone behaves as he does, when estimating the implication of other's actions with respect to social well-being, the agents is using a Kantian vision.

Naturally, this representation could be considered naive in face of reality. Why should each individual expect others to behave as he does? The weighting parameter α answers this question. Larger values of α mean that the agent is being more 'Kantian' relative to homo-economic. Hence, those who care nothing for public well-being (or at least, do not behave as if they care) have $\alpha \approx 0$. Those who care and behave the best have $\alpha \approx 1$.(13)

Agent's Behaviour

Depending on his attitude towards the environment, concern and behaviour will emerge with different strengths. For example, someone with a stronger green attitude will have higher levels of concern for the environment and hence a greater response toward environmental conservation - or green behaviour. Following the model, the agent can choose to behave green $(y = 0)$ or grey $(y = 1)$. For each case we have that:

$$\text{Green (y=0):} \qquad u\left(\tfrac{1}{1+\rho}\right) - \alpha \cdot d[(1-\delta)p_{t-1} + 0]$$

$$\text{Grey (y=1):} \qquad u(1) - \alpha \cdot d[(1-\delta)p_{t-1} + \gamma]$$

Obviously he will behave green if the first term is greater or equal to the second one. Applying this inequality to the previous equations and rearranging the terms, we get:

$$\alpha \underbrace{[d((1-\delta)p_{t-1} + \gamma] - d((1-\delta)p_{t-1})]}_{\substack{\Delta d\,:\,\text{social cost of} \\ \text{behaving grey}}} \geq \underbrace{u(1) - u\left(\tfrac{1}{1+\rho}\right)}_{\substack{\Delta u\,:\,\text{cost of} \\ \text{behaving green}}} \tag{2.8}$$

$$\alpha\ \Delta d \geq \Delta u$$

(11)The original Categorical Imperative (or one of the original version) was: "So act as if the maxim of your action were to become through your will a universal law of nature." Kant (1785) [11].

(12)For a nice essay on the relationship between the Kantian imperative and Climate Change see Rentmeester (2010) [25].

(13)There is also another way of tackling this diversity: We might think that each person cares about social well-being with the same intensity, but that the parameter α instead reflects how 'naive' (or optimistic) each person is. For a development of this idea and a proof of its equivalence, see Appendix A.

At this point, two remarks are worth mentioning:

- $\Delta d(\gamma, \delta, p_{t-1}) = d[(1-\delta)p_{t-1} + \gamma] - d[(1-\delta)p_{t-1}]$ is increasing in p_{t-1} (since $d'' > 0$).
- $\Delta u(\rho) = u(1) - u(\frac{1}{1+\rho})$ is increasing in ρ.

The first observation implies that having higher perceived pollution levels, p^p_{t-1} (which is equal to p_{t-1}), will yield more people adopting green behaviour. This is simply because the condition in 2.8 is met for lower values of α when $\Delta d(\gamma, \delta, p_{t-1})$ increases. Therefore, a higher proportion of society will choose to be green. The second remark corresponds to the obvious fact that the more expensive the green product is (higher values of ρ), the higher the cost (in terms of consumption) that will be borne by agents behaving green.(14)

Therefore we can see that for a given price of the green product and a perceived pollution level, there is a value of α^* that *divides* the society in two: those behaving green ($\alpha \geq \alpha^*$) and those behaving grey ($\alpha < \alpha^*$). Hence we can define a function $\theta(p_{t-1}, \rho)$ that tells us the proportion of people behaving grey for the values of p_{t-1} and ρ, as:(15)

$$\theta(p_{t-1}, \rho) = \min\left(\frac{u(1) - u(\frac{1}{1+\rho})}{d[(1-\delta)p_{t-1} + \gamma] - d[(1-\delta)p_{t-1}]}\ ,\ 1\right) = \min\left(\frac{\Delta u(\cdot)}{\Delta d(\cdot)}\ ,\ 1\right) \quad (2.9)$$

I note two remarks about this new function $\theta(\cdot)$:

- There is a level of p_{t-1} ($p_{t-1_{min}}$) where, below this point, everyone behaves grey. In other words, the environment is clean enough such that no one 'cares' about it:

  Setting $\alpha = 1 \quad \rightarrow \quad d[(1-\delta)p_{t-1_{min}} + \gamma] - d[(1-\delta)p_{t-1_{min}}] = \Delta u$

- There will be always some people behaving grey:

  We can always find $\alpha < \epsilon$, such that $\alpha\ \Delta d < \Delta u$, for any given $p_{t-1} > 0$ and $\rho > 0$. It is easily verified when using $\alpha = 0$: the agent has no incentive at all to behave green.

(14) An interesting feature to note is that if we consider consumption levels as proportional to some income level w (i.e. comparing $u(w)$ and $u(\frac{w}{1+\rho})$), the cost of behaving green, Δ_u, could be increasing, decreasing or independent of the income level w, depending on the functional form of $u(\cdot)$. Since in this formulation I explicitly leave aside the income effect, I use for simulations the case where $u(w) = \ln(w)$, which gives us a Δ_u that is independent of w. For details see Appendix B.

(15) For the present and following definitions, I use a uniform distribution of α. If this were not the case, we would have a different function $\theta(\cdot)$, but it would still retain the subsequent properties and results.

We can graph this function with respect to p_{t-1}, for a given value of ρ, as in Figure 1.

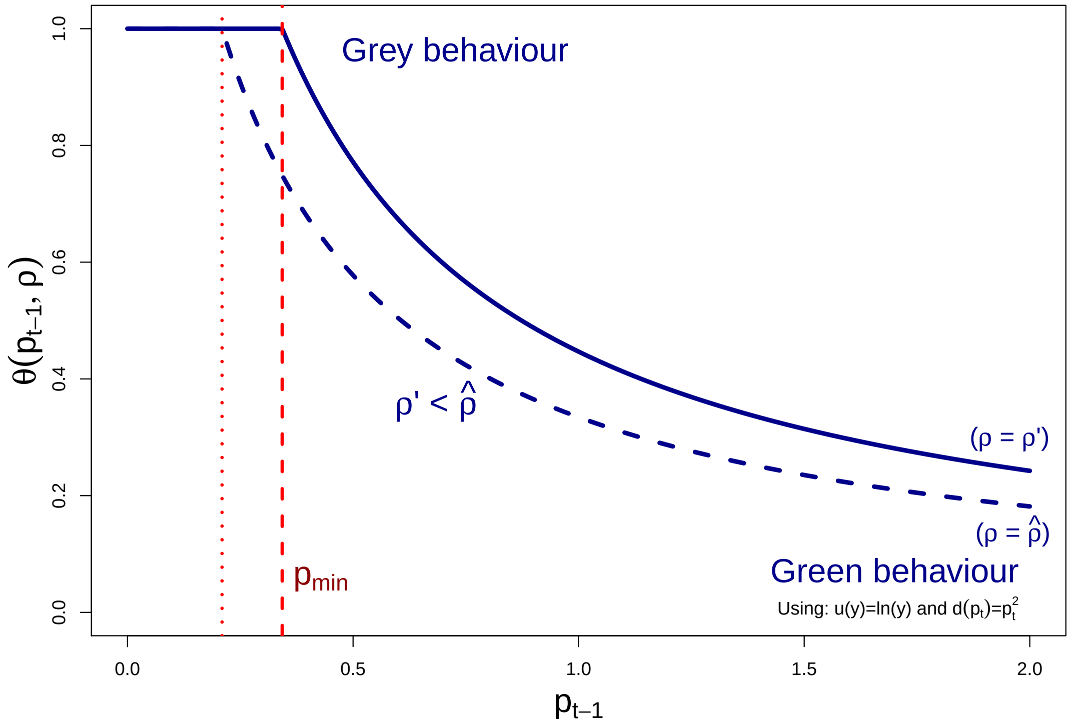


Figure 1: Share of grey behaving people w/r to perceived pollution level.

As we can observe in the illustration, a lower value of ρ (having a cheaper green product) will mean that more people adopt green behaviour as pictured with the dashed line. We can also notice that below a threshold level of pollution p_{min}, everybody behaves grey: $\theta(p_{t-1}, \rho) = 1$. The intuition for this is quite straightforward: The environment is too clean to 'care' about it, and therefore, no one does. Or, since the environment is so clean, it is simply too expensive to behave green. We can also note that as the environment grows worse, the society becomes greener. This last observation comes from the fact that $\Delta d(\gamma, \delta, p_{t-1})$ is an increasing function of p_{t-1}. But it is also intuitive. As the environment worsens, more people (those with less of a green attitude) become more aware and begin to prefer green behaviour.

Now we can return to the pollution evolution (Equation 2.3). Rearranging the terms and defining the *change in pollution* as $\Delta p_t = p_t - p_{t-1}$, we have:

$$\Delta p_t = \underbrace{\gamma\, \theta(p_{t-1}, \rho)}_{\substack{\text{Actual} \\ \text{emissions}}} - \underbrace{\delta p_{t-1}}_{\substack{\text{Natural} \\ \text{absorption}}} \tag{2.10}$$

The first term corresponds to present emissions: it is the impact of consumption/production on the environment (γ) multiplied by the share of people behaving grey ($\theta(\cdot)$)

multiplied by their grey consumption, which is 1. The second term is the natural absorption of the pollutant.

We can now graph these two terms as in Figure 2.[16] As we can see from the figure,

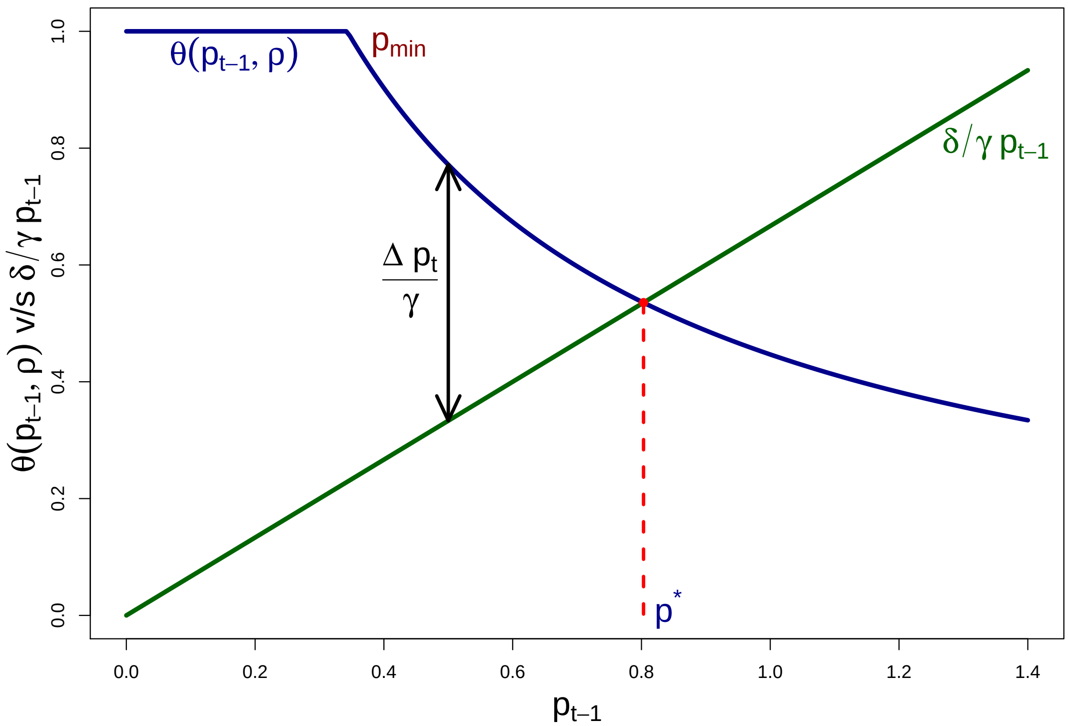


Figure 2: Evolution of pollution.

starting from a low level of pollution, $\Delta p_t > 0$, meaning that we will be polluting faster than what Mother Nature can absorb in the same period of time. At the beginning, for low levels of p_{t-1}, the society will behave completely grey, $\theta(\cdot) = 1$, and from a point, p_{min}, we will see more and more people behaving green (decreasing section of curve $\theta(\cdot)$). This curve will cross the straight line $\delta/\gamma\ p_{t-1}$ which represents the amount of pollution captured in a natural form. At this point, $\Delta p_t = 0$ means that the system stops evolving. It is easy to see that this equilibrium point is stable, since going further to the right will make $\Delta p_t < 0$.

[16]The figure has been rescaled by a factor of $1/\gamma$ in order to use the same previous Figure 1 and for simplicity in coming sections.

Let us now rotate the graph counter-clockwise, which will make it easier to analyse for further discussion. In doing so, we obtain Figure 3. As we can see in this figure, we now

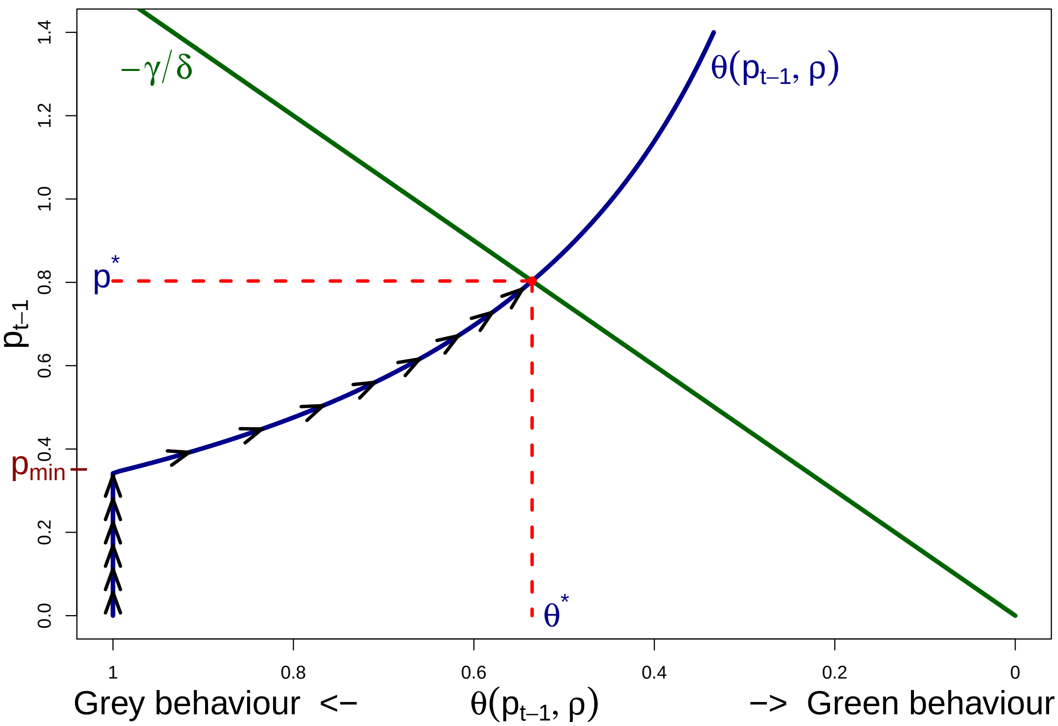


Figure 3: History of pollution.

have the pollution level on the y-axis and how green the society is on the x-axis (being the greenest on the right side). The straight line (denoted by $-\gamma/\delta$) is again the natural absorption of pollution. The negative sign and change in terms comes from the rotational process. Since we know that when it crosses the curve $\theta(p_{t-1}, \rho)$ the system is at equilibrium, it is handy to leave it in the graph. In the same fashion, $\theta(p_{t-1}, \rho)$ in Figure 3 is the rotated version of $\theta(p_{t-1}, \rho)$ in Figure 2. Using an 'historical' approach, we begin from the lower-left corner and we then follow the arrows. At this starting point, there is no pollution and therefore everybody behaves grey, $\theta(\cdot) = 1$ (recall that the x-axis is inverted). This led to increasing levels of pollution, up to some point where people began to care about the issue, p_{min} (the kink to the right). As society continues to pollute, it becomes more aware of the issue and becomes greener. Society then reaches a point where emissions will be equal to natural absorption, at (θ^*, p^*). At this point, a proportion $(1 - \theta^*)$ of the society is aware enough to behave green, which translates into an emission level equal to what Mother Nature can absorb at that pollution level p^*.

Endogenizing ρ: Introducing a political framework

I now introduce a simple political framework with two parties: the green party and the grey party. They only differ in their views about the environment, such that each party has a different environmental policy. For simplicity, I assume that the grey party does nothing about the environment, whereas the green party will implement a green-oriented policy. In this set-up, a green policy will simply be some tax/subsidy scheme to reduce the price gap between the green and grey products. This policy could be accomplished by taxing the grey products, subsidizing the green ones, or using both instruments at the same time. In other words, the green government will lower ρ, while the grey government will alter nothing.

It is implicitly assumed in this simple framework that as $\theta(p_{t-1}, \rho)$ decreases (and the society becomes greener), the government elected will implement a policy where ρ gets smaller. I base this assumption on an environmentally ideological basis in the sense that green people will prefer green policies of this type. This idea also is supported by the results found by Comin and Rode in their paper "From green users to green voters" (Comin and Rode (2013) [6]). They show that as more German families started using photovoltaic panels, the Green Party received better results in the elections.

Following the previous reasoning, we know that the elections will be won by the choice of the median voter. In other words, when the share of green people is bigger than some threshold $(1 - \overline{\theta})$ (and, hence, $\theta \leq \overline{\theta}$) a green government will be elected. In a simple case where α is uniformly distributed, we have that $\overline{\theta} = 1/2$.

On the other hand, we have seen that if the value of ρ decreases, the function $\theta(p_{t-1}, \rho)$ will change, as seen in Figure 1. Now, since this policy is 'active' only when $\theta(\cdot) \leq \overline{\theta}$ (on the right side of the graph), we have a $\theta(p_{t-1}, \rho)$ function with a discrete jump at $\overline{\theta}$, as in Figure 4.

We can notice that we have two equilibria: θ_1^* a 'grey' equilibrium and θ_2^* a 'green' one. In the example depicted $\theta_1^* < \overline{\theta}$. This gives us the possibility of two equilibria.

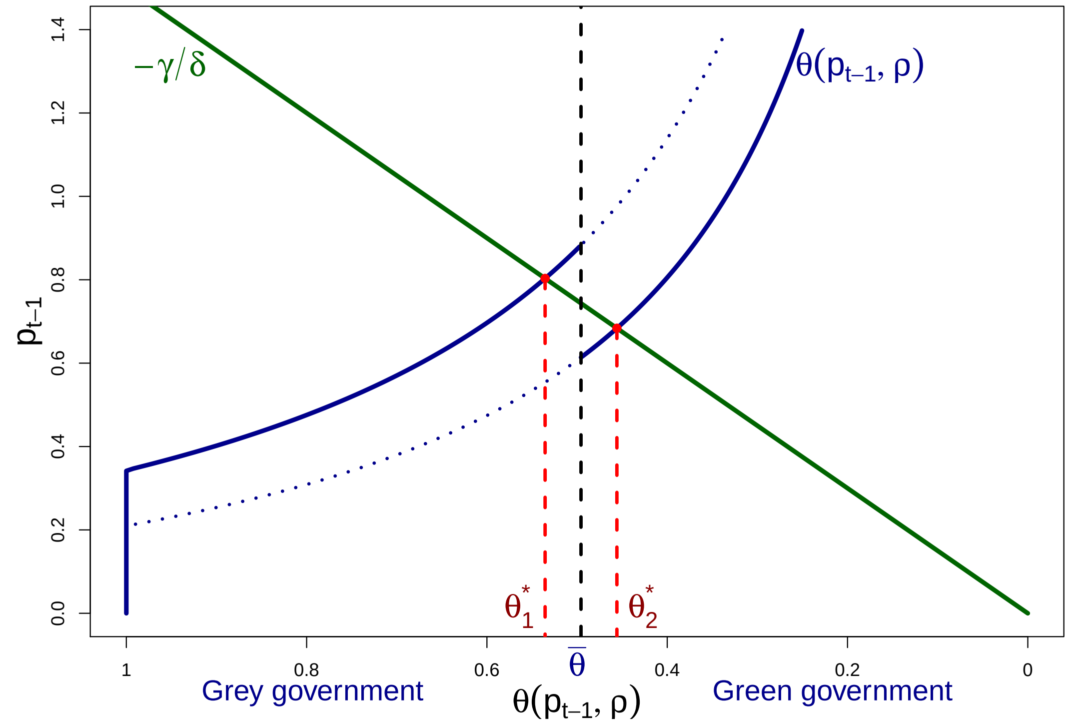


Figure 4: A green government.

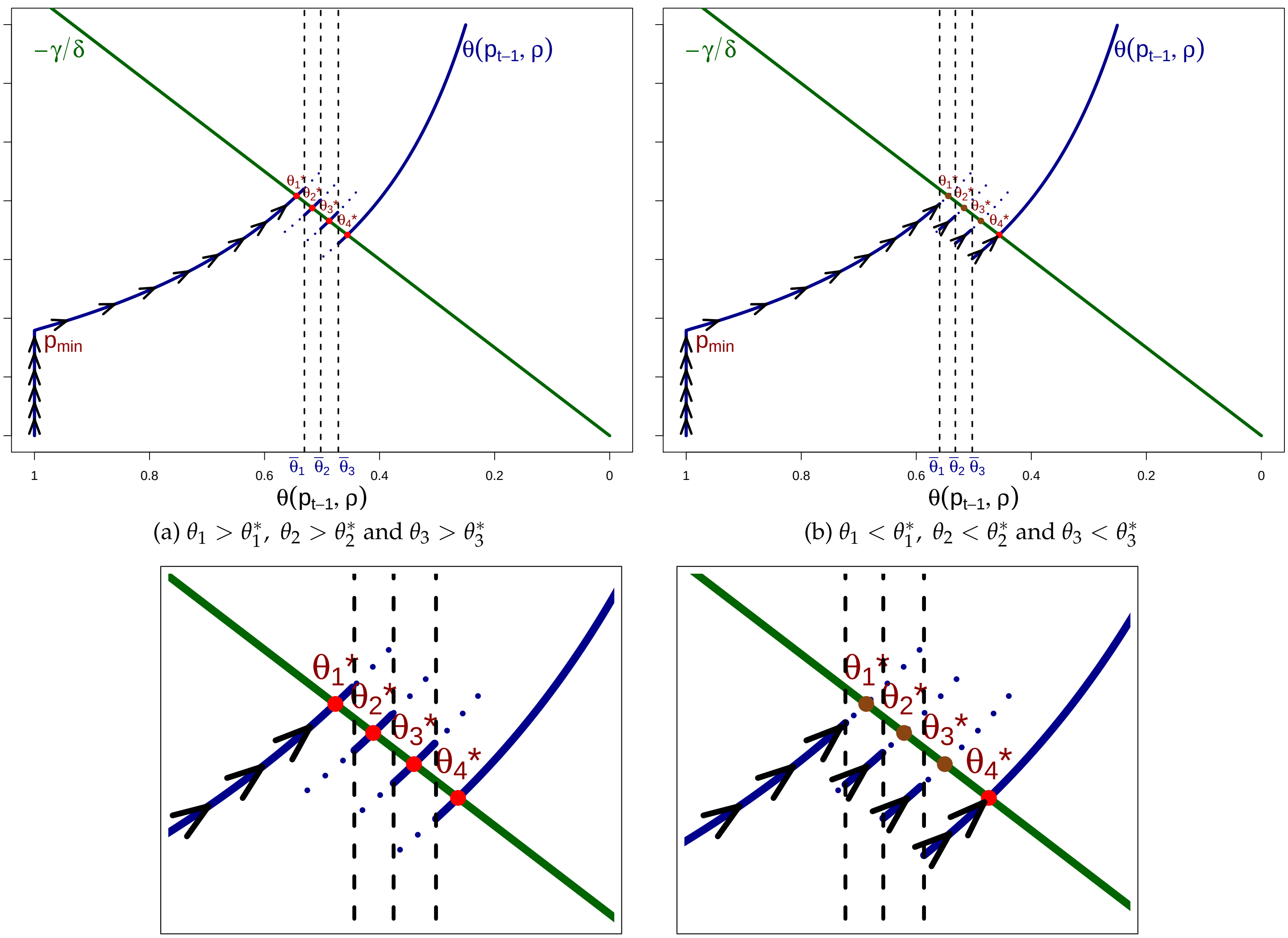
Now let us suppose that we are in a political framework with more parties involved (in the environmental spectrum). This assumption comes from the fact that, in the political arena, other topics are also involved in voters' (and politicians') decisions, such as income distribution, educational policies, etc. If this is the case, we can expect to have more 'jumps' in the dynamics, on the left and right side of $\overline{\theta}$. This can be due to:

- The fact that coalitions might form in order to get this 'multi-dimensional' median voter.
- A party or coalition might be willing to implement some green policy (a ρ level between the no policy and the full policy) in order to gain green voters. They are trying to get voters which also share other political dimension(s) with this party or coalition.

If this is the case, we could have the following set-up:

- $\theta > \overline{\theta}_1 \quad \rightarrow \rho_1$ (100% grey government)
- $\overline{\theta}_1 \geq \theta > \overline{\theta}_2 \quad \rightarrow \rho_2$ (partially grey government)
- $\overline{\theta}_2 \geq \theta > \overline{\theta}_3 \quad \rightarrow \rho_3$ (partially green government)
- $\overline{\theta}_3 \geq \theta \quad \rightarrow \rho_4$ (100% green government)

with $\overline{\theta}_1 > \overline{\theta}_2 > \overline{\theta}_3$ and $\rho_1 > \rho_2 > \rho_3 > \rho_4$. In this case, we can have different outcomes with $\overline{\theta}_1 \lesseqgtr \theta_1^*$, $\overline{\theta}_2 \lesseqgtr \theta_2^*$ and $\overline{\theta}_3 \lesseqgtr \theta_3^*$. Two cases are depicted in Figures 5a and 5b:



(a) $\theta_1 > \theta_1^*$, $\theta_2 > \theta_2^*$ and $\theta_3 > \theta_3^*$

(b) $\theta_1 < \theta_1^*$, $\theta_2 < \theta_2^*$ and $\theta_3 < \theta_3^*$

(c) Zoom of Figure 5a.

(d) Zoom of Figure 5b.

Figure 5: Different possibilities for multiple equilibria.

Observing the arrows drawn in Figure 5a, we can see how a natural evolution of the environment and society's behaviour could progress. As before, the system starts from the bottom left corner, where there is no pollution and everyone behaves grey. Again, at some point (p_{min}), some people start to behave green and the system begins to shift to the right (always increasing). In this first case (Figures 5a and 5c), the system will arrive at equilibrium θ_1^*. But if conditions for Figure 5b (and 5d) are met ($\overline{\theta}_1 < \theta_1^*$, $\overline{\theta}_2 < \theta_2^*$ and $\overline{\theta}_3 < \theta_3^*$), then the story is a different one. When moving towards θ_1^* the system crosses the $\overline{\theta}_1$ threshold, jumping to a lower level of ρ (ρ_2) and not reaching the equilibrium θ_1^*. But it now moves towards θ_2^*. This process is repeated with $\overline{\theta}_2$ and $\overline{\theta}_3$ to finally arrive at equilibrium point θ_4^*. In other words, as the society becomes greener in its behaviour, greener governments get elected. If the conditions are 'right', this might produce a cascading process that concludes with the (fully) green government in power.

However, the political framework might not be the only source of change in ρ. Another way of endogenizing ρ is from an evolution in the production process of the green products. As society becomes greener and more green products are bought, it would be logical to expect that: a) economies of scale begin to appear and; b) technological innovations occur in green product production methods (in contrast to a more mature grey production technology). Again this last point could be 'artificially' induced by a political agreement, responding to the society's demands. In the end, either method of endogenizing ρ leads to the same result: the system has a tipping point from which it moves toward a greener equilibrium.

3 A Green Nudge

As we saw in Figures 5a and 5b, all we need to nudge the system is to shift the threshold levels $\overline{\theta}_i$ or to move the curve $\theta(\cdot)$, even temporally. In this previous example, the two societies were not precisely the same, but I choose this framework in order to exemplify how a 'jump' from a grey equilibrium θ_1^* into a greener one θ_4^* might occur. To do so, we should recall that function $\theta(\cdot)$ depends on the price (differential) of the green product ρ as well as on the perceived pollution. This last term, as its name indicates, has to do with how people perceive the pollution levels, which I initially assumed to be correctly perceived ($p_{t-1}^p = p_{t-1}$ used in equation 2.4). Now we can assume that the agent has a perception bias Ω, giving us the following relationship: $p_{t-1}^p = \Omega\, p_{t-1}$. Changing the value of Ω will shift the curve $\theta(p_{t-1}, \rho)$ left or right. Hence, if we are able to change this bias, intentionally or by chance, then we could push the system from the grey equilibrium (or path) into the green one. As we expect, this variation does not need to be permanent. When the system has crossed the last threshold ($\overline{\theta}_3$), then there is no longer a need of such a nudge in order to sustain the later equilibrium.(17)

The change in Ω could be due to different causes. The perception of pollution levels depends on information. A higher exposition to information about climate change, which identifies the true environmental conditions, might alter this parameter. Extreme natural events, such as hurricanes hitting more frequently and severely (as with superstorm Sandy), could have the same impact (Ming et al. 2013 [15]). We have also seen how public attitudes dramatically changed after the Deepwater Horizon oil spill and Fukushima

(17)We can see from this reasoning that it is not necessary to know exactly where the thresholds are, but only to be aware of the ability to nudge the system to a greener equilibrium, given these thresholds.

Daiichi nuclear accident. These are not exactly the same phenomena modelled here, but the effect of external information on people's awareness and behaviour is the same. In the wake of the Fukushima Daiichi nuclear accident, the fear of having nuclear disasters elsewhere grew considerably, even to the point where Germany permanently shut down eight of its reactors and pledged to close the rest by 2022. A similar sentiment arose in Italy, where more than 94% of voters opposed the government's plans to resume nuclear power generation in a June 2011 referendum. However, other major global players like United States did not change their policies in reaction to this event - not, at least, for these motives.

But increasing information or changing perceptions are not the only ways of inducing change. Other avenues exist for nudging the system. One such channel could be political 'noise'. Specifically, a country could be close to its tipping point when a greener government is elected due to non-environmental reasons (left vs. right, social reforms, etc.). When this government implements green policy measures, this action could also trigger a cascading path into the green equilibrium. Independent studies by NGOs or the media might also yield the same type of nudge by increasing awareness about the environment and, hopefully, causing constituencies to push for changes to public policy.

In the same vein, it is worth noting that a multi-threshold situation, which means that there is more than one $\overline{\theta}_i$, eases the switching process. If we have a similar situation with more thresholds levels, centred in $1/2$ for example (meaning, half of them on the $\theta(\cdot) < 1/2$ side and the other half on the $\theta(\cdot) > 1/2$ side), it is straightforward that the cascading process begins at a lower level of 'greenness' of the society (starting at higher levels of $\theta(\cdot)$). In this sense, having a political arena where coalitions are more likely to form, could facilitate this switching process, increasing its likelihood of happening.

4 Social Approval and Social Pressure

So far I have used an *absolute* moral gain, meaning that the moral or green motivation of the agents comes only from an inner motivation. He does what he is doing because he thinks it is the good thing to do (the Kantian idea discussed so far). I introduce now what I will call a *'relative'* moral gain. In this case, the agent will also derive utility from being accepted by his peers and the society in general. This idea has already been discussed in Hollander (1990) [10], Nyborg et al. (2003) [18] and Rege (2004) [24]. This concept is quite simple: I get positive feedback from people behaving as I am behaving.(18) Therefore I

(18)It is interesting to note that this peer effect has also to do with how 'public' our green actions are. In other words, we can declare that we behave quite green, when maybe in reality we do not. A clear example of this can be found in Byrnes et al.(1999) [5], where they show a real life example from an electric call $u_a(\cdot)$ the satisfaction from *social approval* that agents get, which will in turn depend on his behaviour and on society's behaviour $\theta(\cdot)$. A corresponding weighting parameter β is introduced, producing the following version of the agent's utility function:[19]

$$U(\cdot) = u_p + \alpha\, u_s + \beta\, u_a \tag{4.1}$$

Concerning the form of u_a, I will assume that the agent gets a (positive) social reward from people behaving as he does.[20] To have clearer notation, I will denote $\theta(\cdot)$ with θ_t, which is the share of grey people in the society at time t. The function $v(\cdot)$ will transform the share of people behaving as the agent behaves into social pressure, which is a strictly increasing function with $v(0) = 0$ and $v(1) = 1$ for normalization. In other words, this function is translating the social behaviour θ_t into social pressure. Hence we have a piecewise function:

$$u_a(y, \theta_t) = \begin{cases} v(1-\theta_t) & \text{if } y = 0 \quad \text{(behaving green)} \\ v(\theta_t) & \text{if } y = 1 \quad \text{(behaving grey)} \end{cases} \tag{4.2}$$

utility green pricing program. Despite this fact, it is undoubtable that social pressure exists and especially nowadays where social networks play an important role in this matter.

(19)It could be thought that the agent interacts more with people behaving as he is doing, and therefore only has some probability of meeting with a random person, as in Bisin and Verdier(2000) [3]. It turns out that the resulting dynamics are the same, with a minor redefinition of the parameter β.

(20)I therefore disregard the case of negative social pressure from people *not* behaving as the agents does. It is easy to see though that including this second effect will not change the results.

We can immediately notice that if the society is mainly behaving grey ($\theta_t > 1/2$), the agent will *'tend'* to behave grey, and vice-versa. Recalling condition 2.8 for behaving green and updating it to this new set-up, we have:

$$\alpha \; \Delta d(\gamma, \delta, p_{t-1}) \; + \; \underbrace{\beta \left[v(1-\theta_t) - v(\theta_t) \right]}_{\substack{\Delta a \,:\, \text{difference} \\ \text{in social approval}}} \; \geq \; \Delta_u(\rho) \tag{4.3}$$

In other words, when $\Delta_a > 0$, which occurs when $\theta_t < 1/2$, a bigger share of the society will behave green, and vice-versa.(21) We can observe two things now:

- The minimum pollution where people start behaving green will be higher than the case without social pressure: $p'_{min} > p_{min}$

  If everybody is behaving grey and is affected from this peer effect or *'force'*, the agent will have less incentive to behave green. In other words, the pollution will have to be higher in order for someone to care about it *and* endure this (new) social pressure. To find p'_{min}, we again set $\alpha = 1$ and solve: $\Delta_d(\gamma, \delta, p'_{min}) - \beta = \Delta_u$

- If the peer effect is too strong (β bigger than some threshold $\overline{\beta}$), the society will either behave completely green or grey, switching at some pollution level $\overline{p}$ when $\beta = \overline{\beta}$.

  This follows the same intuition as the result obtained in Nyborg et al.(2003) [18]. They get a society which has two extreme equilibria: completely green or completely grey, with a third unstable equilibria in-between. The intuition is the following: Starting with the case in which everybody behaves grey, when peer pressure is too strong, the pollution will be increasing and still nobody will behave green. But at some (much) higher pollution level $\overline{p}$, some people, even bearing the high peer pressure, will start behaving green. In doing so, the peer pressure will be reduced and therefore more people will also behave green. There will be a domino effect, with more people becoming green and reversing the peer effect towards being green, and therefore reaching a full green society. We can notice that the new function $\theta(\cdot)$ is structurally different than its previous version, meaning that it cannot be worked out from the original set-up. For the proof of the last statement, see Appendix C.

(21)Since $v' > 0$, the point when $\Delta_a = 0$ (neutral social approval: $v(1-\theta_t) = v(\theta_t)$) has to be when $\theta_t = 1/2$. Hence, if $\theta_t < 1/2 \rightarrow \Delta_a > 0$ and vice-versa. In addition, this is a recursive way of defining the new function $\theta(\cdot)$. Another way of modelling this feature, would be to say that the agent reacts to θ_{t-1}, the share of grey people in the previous period. This would introduce a difference equation into the system, where lags would play a role too. In order to keep the model simple, I use the case where the agents instantly responds to society's behaviour.

In order to make the idea clearer, I graph the changes obtained when in presence of peer pressure. The following Figure 6 is the new version of Figure 1 found on page 11.

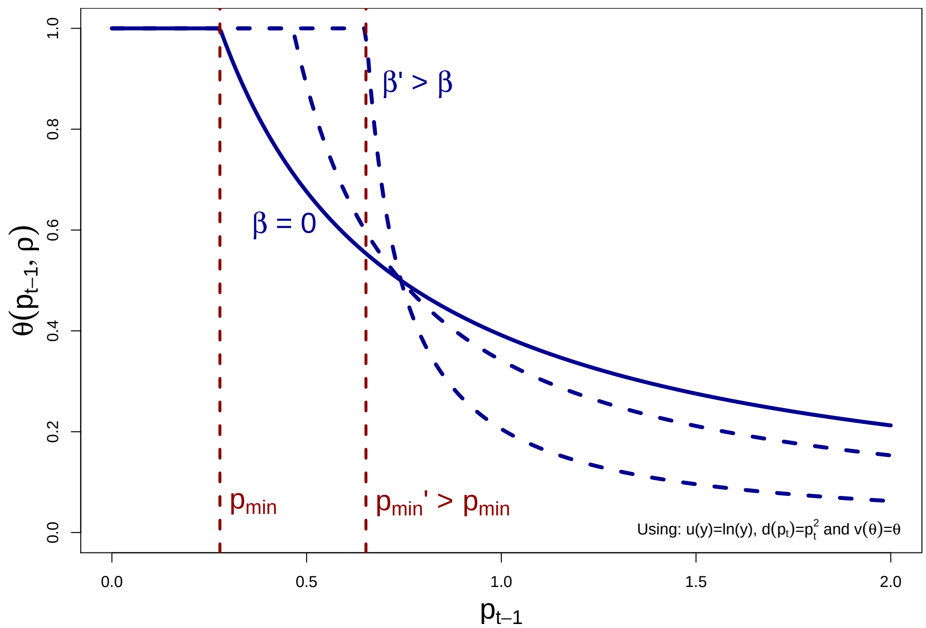


Figure 6: Share of grey behaving people with social approval.

First, we can notice that the three examples cross at a specific point in the graph. This feature is simply the fact that when $\theta_t = 1/2$, the peer effect disappears (it becomes neutral). Therefore for any $\beta \leq \overline{\beta}$, the different curves should intersect at this point. We can use this fact in order to find the value of $\overline{p}$ mentioned before: it is just the pollution when $\theta(\overline{p}) = 1/2$, with the 'original' version of $\theta(\cdot)$. When $\beta > \overline{\beta}$ we will have a case with hysteresis. In this circumstance, to switch from grey to green the pollution level will have to be bigger than $\overline{p}$. But when the society has switched to green, in order to switch back to a grey society, the pollution level will have to be smaller than $\overline{p}$, hence the hysteresis effect. It is easy to note at this point, that the original version of $\theta(\cdot)$ and the actual one are structurally different.

Below I rotate again the figure as I did before, in order to analyse how a society could evolve in the presence of peer pressure. As we can notice in Figure 7 (the updated version of Figure 4, found in page 15), the basic idea is the same. Now, however, the equilibrium points have moved apart from each other.

We can understand this effect as coming from some kind of *'attractors'* situated in each extreme ($\theta = 0$ and $\theta = 1$). Since in this particular case each equilibrium point is situated in either 'half' of the portrait ($\theta < 1/2$ and $\theta > 1/2$), they shift to the left and right side, respectively. Therefore, the resulting equilibria are more separated than before: the societies now behave dissimilarly. We can observe this in the two arrows drawn in the figure.

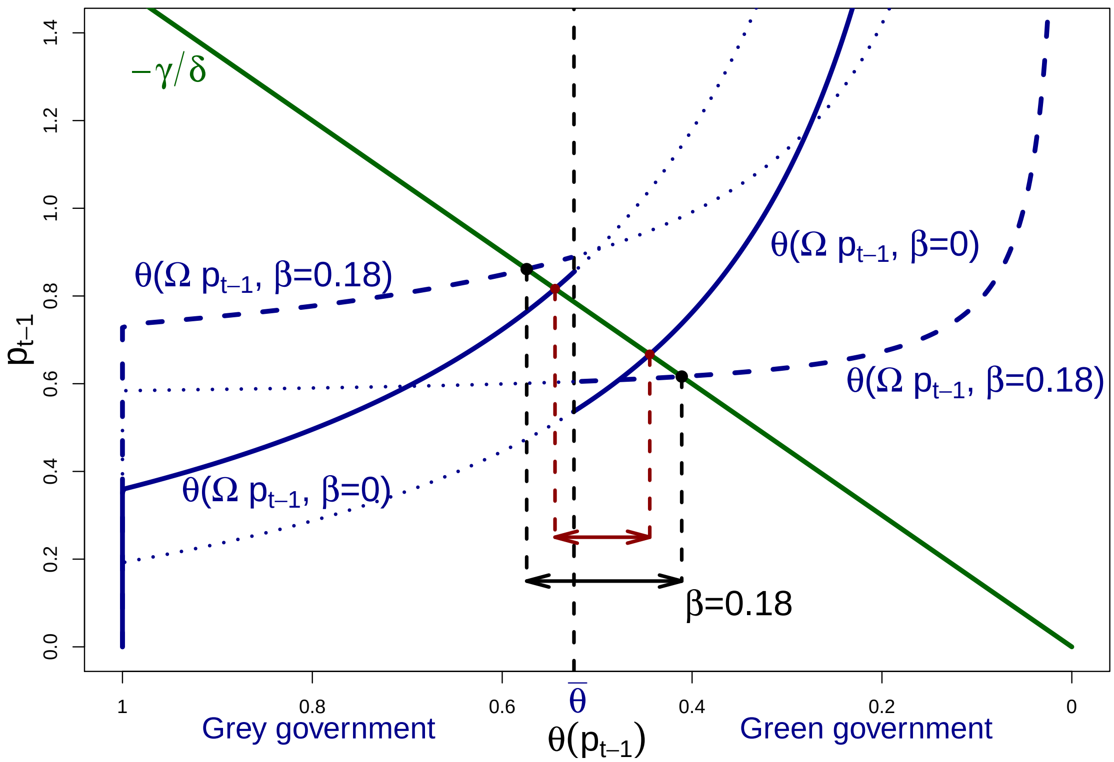


Figure 7: Two equilibria with social approval.

Recalling the cascading effect seen in the preceding pages, we can notice now that this peer effect has detrimental consequences: the threshold needed to switch regimes is bigger ($\overline{\theta}$ has to be bigger) and at the grey equilibrium, the pollution is higher. For this reason it would be desirable (in order to switch to the green side) to eliminate this grey peer effect. This idea may sound a bit too optimistic, but fortunately history might be on this side. Thirty years ago, smoking was considered trendy. We were in the presence of the same effect: being a smoker was fashionable and others were encouraged to behave as smokers did. Nowadays this 'pro-smoking' peer effect has almost completely disappeared or even become negative. Being a smoker is not considered good, even for smokers! It is easy to see that a negative grey peer effect will have a positive outcome regarding the equilibrium and also for the chances of nudging the system.

Hence, if we can induce this negative grey social pressure, as for example with appropriate advertising, we could again induce this cascading process. Looking at the green side of the system, we might also note that the green peer effect is beneficial for society, at least in pollution terms, and it would drive society into lower levels of contamination. We have a second effect that shows up: being in presence of a green policy (lower levels of ρ) and having a peer effect ($\beta \gg 0$) pushes the system into a switching type. In other words, having a strong green social pressure and having cheap green products encourages a great share of people to behave green. We can observe this in the shape of the curve $\theta(p_{t-1}, \Omega, \beta = 0.18)$ which resembles a step function. We can again recall the smoking example: nowadays smoking is socially frowned upon.

5 Conclusions

This model attempts to explain why similar developed countries take different actions with respect to the environment. To do so, I model society as being composed of different types of people: from those who possess stronger attitudes toward the environment up to those who do not care at all about the environment. Green behaviour derives from moral motivations. People with stronger green attitude follow, up to some extent, a (green) Kantian Imperative which makes them more prone to behave green. With this set-up, people can either behave green (contribute to the environment) or grey. The model reveals that the same society can arrive at two different equilibria which might explain differences in environmental policies. This framework might also explain why countries with low income levels sometimes care about the environment more than their developed counterparts, as shown in Lee et al. (2013) [15].

Using the result of multiple equilibria, I have also shown that it is possible to switch from a grey trajectory to a green one. Providing information to people, for example, can raise their awareness about the environment and increase the chances of social change. This outcome reinforces the findings of Corbett and Durfee (2004) [7] and Dunwoody (2007) [8], who show that mass media has a large influence over social concerns, which can result in changes to a country's environmental behaviour and, eventually, its legal framework.

Is the nudge idea a concept that could be applied to explain different behaviours between Europe and the United States with respect to environmental issues such as carbon dioxide emissions? It might be the case that Europe's history of acid rain changed European perceptions and awareness about transnational pollution. When European countries faced acid rain caused by their neighbours' emissions, they became quite aware of the issue and had to establish international environmental agreements, although only regarding these countries. This was not the case in North America, since acid rain was primarily resolved via nationwide actions of the US government. But this could be a bifurcation from an European grey path and could actually explain, up to some extent, the difference in behaviour between North America and Europe.

The present model does not try to provide a full explanation of this phenomenon, but to give some alternative insights of what could be occurring. The whole model assumes that each person's green attitude is fixed. In other words, it is as if people were born with this trait and there is no chance to change it over time. Obviously this is an extreme assumption. However, the idea here is to create a model that can explain faster changes in green behaviour, as observed nowadays.

Hence, we could introduce a second slower evolutionary process of green attitude α (rather than using changes in behaviour directly). This process could be understood by how education, for example, changes attitudes over time. Such a change would be of the type described and modelled in Bisin and Verdier (2000) [3]. New generations approach environmental issues in a different way from their older cohorts, especially when they are taught about the environment (and the complications from environmental damage) from childhood. A possible empirical result of this effect is studied in Hersch and Viscusi (2005) [9]. The authors show that younger generations are greener than older generations. Adding this extension to the model would not change the previous results (especially the one concerning the nudge) and it would moreover reinforce the idea of how specific countries treat the environmental issue differently from a 'cultural' point of view. This last point could be a track for possible extensions of the present work.

It could also be interesting to explore the relationship between people's concern and their actions. In some cases it seems that public is *"concerned but unmoved"* Oppenheimer (2006) [20]. It seems as though this connection could be linked to people's values (Leiserowitz (2006) [16]), which could be developed using a model with an evolution of attitudes.

Another extension might concern the inter-relationship between the change in social awareness and/or behaviour and a more complex model of the political framework. A further line of work could be to verify this model with some empirical information. Unfortunately some variables used in this set-up, as for example the concern of people and green attitude, are hard to properly measure. Even so, it would be a worthy venture to pursue.

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A 'Kantian' index and 'Naiveness' index equivalence.

As stated in the main section, there is also another way of tackling the diversity among agents. We might think that each person cares about social well-being with the same intensity, but that the parameter α instead reflects a person's naivete or optimism. From this idea, we can use α as the share of individuals within society that each person thinks (or hopes) will behave as he does. I show here that this approach is equivalent to the approach outlined in the main section of the paper. In the main text, the original utility function is:

$$U(y) = u(y) - \alpha \cdot d[(1-\delta)p_{t-1} + \gamma \cdot y] \tag{A.1}$$

Now we might think of α as a 'naiveness' measure instead of a 'Kantian attitude' measure. This means that α will now reflect now which proportion of the society the agent is expecting (or hoping) to behave as he does. In this new case, we get the following formulation:

$$U_2(y) = u(y) - d[(1-\delta)p_{t-1} + \alpha \cdot \gamma \cdot y] \tag{A.2}$$

Following again the same reasoning of the main section, we have that the agent will behave green if $U_2(0) \geq U_2(1)$. We proceed again in the same fashion by rearranging terms and getting, for both cases (original and new), the following conditions for behaving green:

$$\underbrace{\alpha\,[d((1-\delta)p_{t-1} + \gamma) - d((1-\delta)p_{t-1})]}_{\substack{\Delta d(\alpha,\gamma,\delta,p_{t-1})\text{ : social cost of} \\ \text{behaving grey}}} \geq \underbrace{u(1) - u(\tfrac{1}{1+\rho})}_{\substack{\Delta u(\rho)\text{ : cost of} \\ \text{behaving green}}} \tag{A.3}$$

$$\underbrace{[d((1-\delta)p_{t-1} + \alpha\cdot\gamma) - d((1-\delta)p_{t-1})]}_{\substack{\Delta_2 d(\alpha,\gamma,\delta,p_{t-1})\text{ : new version of} \\ \text{social cost}}} \geq \underbrace{u(1) - u(\tfrac{1}{1+\rho})}_{\substack{\Delta u(\rho)\text{ : same as} \\ \text{before}}} \tag{A.4}$$

We can again define an α^* that divides the society into those behaving green and grey. The only thing to do now is to check if this new function $\theta_2(\cdot)$ has the same properties as the original one $\theta(\cdot)$. Since the right hand sides of the inequalities are the same, I will only focus on the left hand sides. In the original version, we had the following properties:

$$\frac{\partial \Delta d(\alpha,\gamma,\delta,p_{t-1})}{\partial p_{t-1}} > 0 \qquad \frac{\partial \Delta d(\alpha,\gamma,\delta,p_{t-1})}{\partial \alpha} > 0 \qquad \frac{\partial^2 \Delta d(\alpha,\gamma,\delta,p_{t-1})}{\partial \alpha\ \partial p_{t-1}} > 0 \tag{A.5}$$

It is easy to verify that the same properties will hold for the case of $\Delta_2 d(\alpha,\gamma,\delta,p_{t-1})$. Hence arrive at a new $\theta_2(\cdot)$ with the same properties of $\theta(\cdot)$ (although **not** the same function).

We can finally verify the two remarks made about $\theta(\cdot)$ for $\theta_2(\cdot)$:

- There is a level of $\Omega\, p_{t-1}$ $(\Omega(p_{t-1})_{min})$, where below this point, everyone behaves grey (the environment is clean enough such that no one 'cares' about it):

  Setting $\alpha = 1 \quad \rightarrow \quad d(\Omega(p_{t-1})_{min}) + \gamma) - d(\Omega(p_{t-1})_{min})) = \Delta u$

  This will actually gives us the **same** level of $\Omega(p_{t-1})_{min}$ as before.

- There will be always some people behaving grey:

  We can again find $\alpha < \epsilon$, such that $\Delta_2 d(\alpha, \Omega\, p_{t-1}) < \Delta u$, for any given $\Omega p_{t-1} > 0$ and $\rho > 0$. In the same manner, we can see that since $\Delta_2 d$ is continuous in α and that $\Delta_2 d(\alpha = 0, \Omega\, p_{t-1}) = 0$, then there exists an ϵ such that $\Delta_2 d(\epsilon, \Omega\, p_{t-1}) < \Delta u$ for given $\Omega p_{t-1} > 0$ and $\rho > 0$.

We can finally observe a graph showing both versions of the function $\theta(\cdot)$:

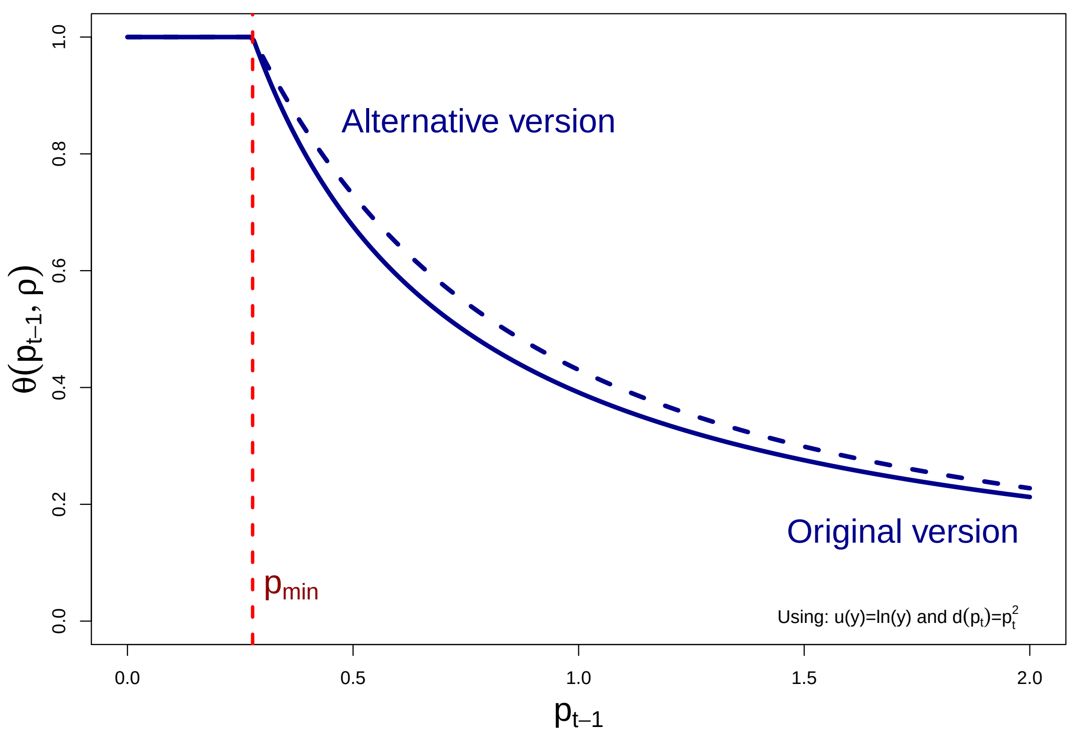

Figure 8: Alternative case where α is the agent's 'naiveness'.

A third and final option might be to think that both mechanisms are in place: how Kantian each person is and how naive they are. For simplicity, I skip this alternative. However, if an individual's Kantian tendency is positively correlated to their optimism, the present results should hold.

B Cost of behaving green under other consumption utility functions.

Depending on the functional form of the consumption utility function, the cost of behaving green Δ_u can be an increasing, decreasing or constant function of the income level w. To observe this feature, I provide four examples using four different consumption utility functions.

$$u_1(c) = \ln(c) \quad \text{(B.1)}$$

$$u_2(c) = \sqrt{c} \quad \text{(B.2)}$$

$$u_3(c) = \frac{c-1}{c} \quad \text{(B.3)}$$

$$u_4(c) = \ln(c+K) \quad \text{(B.4)}$$

with K a positive constant.

Setting the grey and green consumption levels to w and $w/(1+\rho)$ respectively, we get:

$$\begin{aligned} \Delta_u^1 &= \ln(w) - \ln(w/(1+\rho)) \\ &= \ln\left(\frac{w}{w/(1+\rho)}\right) \\ \Delta_u^1 &= \ln(1+\rho) \end{aligned}$$

$$\begin{aligned} \Delta_u^3 &= \left(\frac{w-1}{w}\right) - \left(\frac{w/(1+\rho)-1}{w/(1+\rho)}\right) \\ \Delta_u^3 &= \frac{\rho}{w} \end{aligned}$$

$$\begin{aligned} \Delta_u^2 &= \sqrt{w} - \sqrt{w/(1+\rho)} \\ &= \sqrt{w}\left(1 - (\sqrt{1+\rho})^{-1}\right) \\ \Delta_u^2 &= \sqrt{w}\left(\frac{\sqrt{1+\rho}-1}{\sqrt{1+\rho}}\right) \end{aligned}$$

$$\begin{aligned} \Delta_u^4 &= \ln(w+K) - \ln\left(\frac{w}{1+\rho} + K\right) \\ \Delta_u^4 &= \ln\left(1 + \frac{\rho}{1 + \frac{K(1+\rho)}{w}}\right) \end{aligned}$$

We can observe that Δ_u^1 is constant, meaning it is independent of the value of w. In the second case, Δ_u^2 is increasing proportional to $\sqrt{w}$ (the term in parentheses is positive). In the third case, it is clear that Δ_u^3 is decreasing with w. The last case is a mixture between the first and second cases: Δ_u^4 is increasing with w but, as w grows, Δ_u^4 tends to a fixed value, $\ln(1+\rho)$, the same obtained in the first case.

C An (indeed) different dynamics with social approval.

As stated in section *"Social Approval and Social Pressure"*, adding a social approval gain to the agent's utility function does actually change (structurally) the function $\theta(\cdot)$ and therefore the dynamics. Adding social approval to the utility function will lead to a different functional form in the sense that the new $\theta(\cdot)$ function cannot be found by modifying the original parameters and/or by changing the (shape of the) consumption part $u(\cdot)$.

In order to prove this, we can recall that the original function $\theta(\cdot)$ comes from the Inequality 2.8 (page 9). There, I proved that for a given value of ρ and a pollution level p_{t-1}, there will always be some people behaving grey. I will prove now that this is not the case with social pressure, since it can be the case where for given values of ρ and p_{t-1} (and β), the society can become completely green. Recall the new condition to behave green, as in Inequality 4.3 (page 20):

$$\alpha\ \Delta_d(\gamma, \delta, p_{t-1})\ +\ \underbrace{\beta\,[v(1-\theta_t) - v(\theta_t)]}_{\substack{\Delta a\,:\ \text{difference} \\ \text{in social approval}}}\ \geq\ \Delta_u(\rho) \tag{C.1}$$

Let us verify if this hypothesis, of everybody behaving green ($\theta_t = 0$), is true. In this case, we have that the social approval will be equal to: $\Delta_a(\theta_t = 0) = v(1) - v(0) = 1$. Therefore the previous condition becomes:

$$\alpha\ \Delta_d(\gamma, \delta, p_{t-1})\ +\ \beta\ \ \geq\ \Delta_u(\rho)$$

Now, to verify that everybody is behaving green, we can simply verify this condition for the least green person, the pure-economicous one, who has $\alpha = 0$. Therefore we get:

$$\beta\ \ \geq\ \Delta_u(\rho) \tag{C.2}$$

which is just the minimum weight of the social approval parameter in the agents' utility function. In other words, with this level of influence of peer pressure in agents' utility, even the pure-economicous person bears the cost of behaving green, only because of a social pressure source, and not because of a Kantian incentive, since he has none.