A Toy Model of Individual Environmental Action

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I Motivation

This model discusses a collective component of the determinants of individual environmental action and makes it, at least partly, a coordination problem. This collective component stems from the fact that individual actions are taken in social environments and that actions of others affect one's actions. For instance, there are often network externalities in environmental consumption behavior. The more people own and use electric vehicles, the more charging stations there might be and the less costly it would be for someone using a gasoline powered car to switch to an electric one. Similarly, if no one composts and there are no compost collection points in a city, it would be costly for an inhabitant of this city to start composting on their own. Additionally, conformism can play a central role in determining environmental behavior. Value systems or fashion can affect one choices, through normative and non-normative social beliefs respectively. If most people stop consuming meat, one may stop as well, either because they want to conform to the descriptive norm or because they update their beliefs on what other individuals think one ought to do. Information channels may also affect their decision: observing a different behavior may raise discussions among peers and that way affect ones knowledge on the benefits of the environmental action.

This model is a rhetoric device and is used to serve as a basis for discussion around individual environmental action. It is not novel in any way and is extremely simple. This model is essentially a threshold model and is based on (Heal and Kunreuther 2010). Many other papers also use a similar framework (Le Breton and Weber 2011, Leister et al. 2022, for instance).

II Simple setting

Consider N agents. Individual i either consumes a green good ($s_i = 1$) or a brown good ($s_i = 0$). In a simple first version of the toy model, the utility u of individual i depends on their consumption s_i and the consumption of others s_{-i} and is defined as follows:

$$u_i(s_i, s_{-i}) = \begin{cases} \gamma_i + \dfrac{1}{N-1} \displaystyle\sum_{\substack{k=1 \\ k \neq i}}^{N} s_k & \text{if } s_i = 1 \\ \dfrac{1}{N-1} \displaystyle\sum_{\substack{k=1 \\ k \neq i}}^{N} (1 - s_k) & \text{if } s_i = 0 \end{cases} \tag{1}$$

where γ_i can be considered as the intrinsic preference of agent i for the green good. Note that it serves as a normalization parameter and can be negative. $\frac{1}{N-1} \sum_{\substack{k=1 \\ k\neq i}}^{N} s_k$ and $\frac{1}{N-1} \sum_{\substack{k=1 \\ k\neq i}}^{N} (1 - s_k)$ are the proportions of other individuals consuming the green good and the brown good respectively. These effects can be interpreted as peer effects if the analysis is limited to peer groups (N = number of peers) or more general "society level" effects if N represents all individuals in society. In the later case, it would of course make sense to weight the s_k. In this version of the toy model, the effects evolve linearly with the proportion of others consuming the green good. Yet, in a real setting, these effects are likely non linear. We discuss a more general version below.

II. 1 Conditions to consume the green good

Individual i will consume the green good ($s_i = 1$) iff

$$\begin{aligned} & u_i(1_i, s_{-i}) - u_i(0_i, s_{-i}) > 0 \\ \Leftrightarrow \quad & \gamma_i > 1 - \frac{2}{N-1} \sum_{\substack{k=1 \\ k \neq i}}^{N} s_k \end{aligned}$$

For interpretation purposes, we can assume that "initially" no one consumes the green good. Individuals with higher γ will switch first and then make others shift. Now, without loss of generality, we can assume $\gamma_1 \geq \gamma_2 \geq ... \geq \gamma_N$. Hence, we have:

$$\forall i \in \{1, ..., N\}, s_i = 1 \Leftrightarrow \gamma_i > 1 - \frac{2}{N-1} \sum_{\substack{k=1 \\ k \neq i}}^{N} s_k$$

And as a consequence, conditions to consume the green good are:

$$\begin{aligned} s_1 = 1 \Leftrightarrow \gamma_1 &> 1 \\ s_2 = 1 \Leftrightarrow \gamma_2 &> 1 - \frac{2}{N-1}(\times 1) \\ &\vdots \\ s_l = 1 \Leftrightarrow \gamma_i &> 1 - \frac{2}{N-1} \times (l-1) \\ &\vdots \\ s_N = 1 \Leftrightarrow \gamma_N &> 1 - \frac{2}{N-1} \times (N-1) = -1 \end{aligned}$$

Hence i consumes the green good iff:

- $\gamma_i > 1$

or - all individuals with higher γ have consume the green good and $\gamma_i > h(i)$, where $h : k \mapsto 1 - \frac{2}{N-1} \times (k-1)$, a straight line.

Individual i thus consumes the green good if they have high pro-environmental attitudes or if enough people also consume the green good.

II. 2 Model "results"

Lets now consider the outcomes of the model when $\gamma \sim \mathcal{N}(0, 0.6)$. Figure 1 represents the distribution of γs in the right panel. In the left hand side one, the blue line represents the γs and the pink line h, both as a function of i.

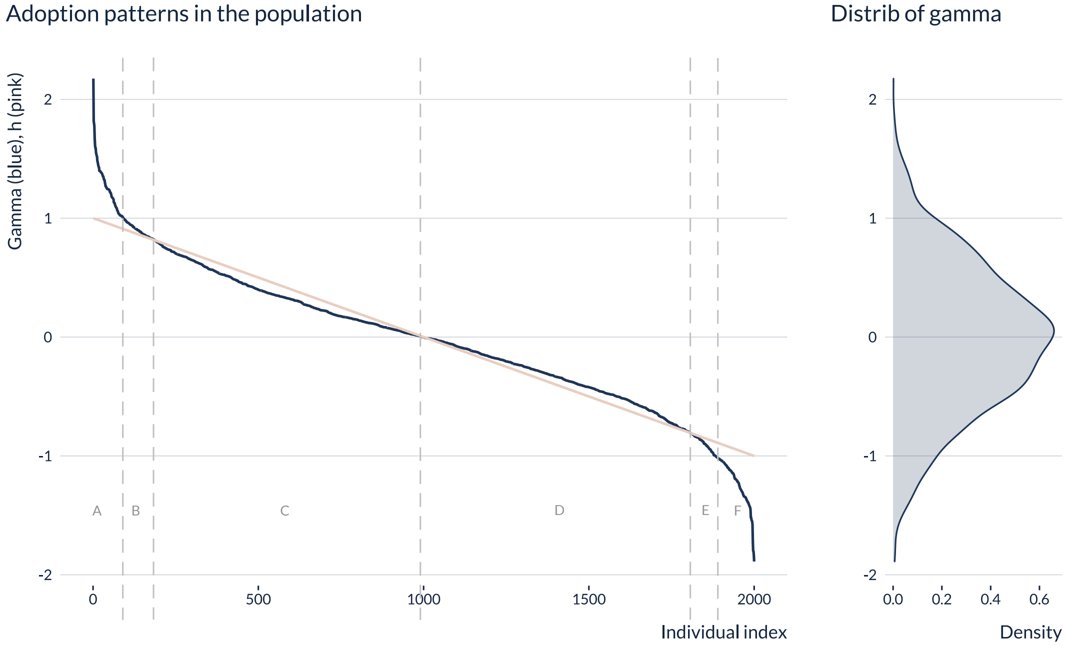

Figure 1 – Example of model results for $\gamma \sim \mathcal{N}(0, 0.6)$

The figure reads more easily from left to right, starting with individuals with higher γs. Individuals whose $\gamma > 1$, those in A, consume the green good regardless of what others do. Individuals in B, would not consume it based on their individual preferences since $\forall i \in B, \gamma_i < 1$. They however consume it because of social interactions: $\forall i \in B, \gamma_i > h(i)$ and all individuals with higher gammas, those in A, consume the green good. Individuals in C do not consume it since $\forall i \in C, \gamma_i < h(i) < 1$. Those in D do not either. They would however consume the green good if all those in C did. They are locked in a position and we end up with a coordination problem. In this setting, most individuals (those in A through E) would consume the green good if all others did. Yet, only a tiny fraction actually does (those in A and B).

Playing around with this simple model spurs interesting results. While keeping the same setting, one can consider with other distributions of γs. The setting can also be made more general.

III A more general setting

Being less specific about functional forms, but still assuming separability between the various terms, we can define the utility of individual i as follows:

$$u_i(s_i, s_{-i}) = \begin{cases} \gamma_i + f(\gamma_{-i}) + g(s_{-i}) & \text{if } s_i = 1 \\ g(1 - s_{-i}) & \text{if } s_i = 0 \end{cases} \tag{2}$$

γ_i represents personal normative beliefs, *ie* intrinsic preference for the green good, as in the simple setting. $g(s_{-i})$ represents factual social expectations, *ie* what individual i expect peers to do. It also encompasses network externality aspects. $f(\gamma_{-i})$ are normative social expectations, *ie* what individual

i thinks peers value (Bicchieri 2017). Distinguishing between factual and normative expectations may matter. Factual social expectations have to do with peers' behavior and not their attitudes while normative social expectations have to do with their attitudes and not their behavior.

There would be of course be plenty of ways to develop this model, for instance:

— By distinguishing between peer and society level effects: separating the norms f and g into a local and global component (maybe look into (Le Breton and Weber 2011)),
— Considering varying environmental attitudes (γs). They could be a function of the consumption of others (signaling) or environmental attitudes of others,
— Developing the network structure, for instance by weighting more the consumption of "central" people,
— Adding homophily by weighting more the consumption of people with similar γ,
— Making the model dynamic and considering several time periods.

References

Bicchieri, C. (2017), Norms in the Wild: How to Diagnose, Measure, and Change Social Norms, Oxford University Press. 4

Heal, G. and Kunreuther, H. (2010), 'Social Reinforcement: Cascades, Entrapment, and Tipping', American Economic Journal: Microeconomics **2**(1), 86–99. 1

Le Breton, M. and Weber, S. (2011), 'Games of social interactions with local and global externalities', Economics Letters **111**(1), 88–90. 1, 4

Leister, C. M., Zenou, Y. and Zhou, J. (2022), 'Social Connectedness and Local Contagion', The Review of Economic Studies **89**(1), 372–410. 1