Inside the bounds of ecological policy-making: human needs and political feasibility in the context of sustainable consumption

Michelle Alfers[1 [0000−0001−9184−9656]], Frederik Banning[1 [0000−0002−1835−6756]], Jessica Reale[1 [0000−0003−0216−145X]], and Elias-Johannes Schmitt[1 [0000−0003−4922−717X]]

Chair of Macroeconomics, Ruhr-Universität Bochum, Universitätsstraße 150, 44801 Bochum, Germany

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Introduction

Over the last decades, the rapidly increasing threat posed by climate change has drawn the growing attention of policymakers and research practitioners. On the one hand, the urge to find alternative means of production and consumption led to flourishing economic literature. On the other hand, the international policy agenda's greater focus on sustainable transition issues has often been followed by insufficient, unclear, or timid political initiatives.

Existing literature addressed the slow political awakening in response to the climate crisis to the intertwined nature between policies' design and socio-economic dynamics, which results in a profound conflict of goals (23; 10). Policymakers must rapidly formulate and implement context-specific policies able to induce quick behavioural changes in households' consumption patterns (5). However, the quick and effective implementation of climate-friendly policy measures must also not impair households' ability to meet their consumption needs (11; 12). Unsatisfied consumers might compromise electoral mandates, ultimately harming policymakers' opportunity to introduce necessary yet potentially unpopular measures (8). Therefore, policy feedback mechanisms arising in the context of climate and ecological crises should not neglect the demand-side dimension of sustainability. In this context, shifting the focus from economically optimal policies to political feasibility (25) seems unavoidable.

Over the past years, ecological stock-flow consistent (eco-SFC) models have been widely used to tackle ecological transition issues and macroeconomic dynamics and advance policy recommendations (see 13; 6; 22; 3; 1, among others). However, the role played by consumer behaviour has been pushed to the margins, despite a radical transition toward carbon-neutral consumption habits is desirable and appears not to have detrimental effects on aggregate output and wealth (2). Research practitioners have devoted greater attention to *sustainable production* processes and firms' investment decisions (24; 9). Eco-SFC models focused on households' behaviour have been developed to tackle inequality and distributional issues in an agent-based setting, capturing more complex macroeconomic dynamics and agents' heterogeneity. Households' heterogeneity, however, has been mainly focused on (i) income levels, (ii) access to credit, and (iii) social classes, i.e. workers vs capitalists (19; 20).

Castro et al. (4) review agent-based models considering climate policy measures and their effectiveness in the context of heterogeneous households. Heterogeneity is usually modelled in terms of varying preferences for low-carbon goods, pro-environmental values and bounded rational decision-making. Few studies address the influence of social networks and opinion dynamics on political feasibility of climate policies (15) and energy system transition (16). However, to the best of our knowledge, the explicit feedback processes between feasibility of climate policies and its economic effects on households' consumption have not yet been modelled.

Model

In light of these considerations, we propose a theoretical hybrid agent-based stock-flow consistent (AB-SFC) model featuring heterogeneous households and a single political entity representing a sustainability-oriented government. It aims at emphasising that "[s]ustainable consumption is not only a policy issue. It also has profound political implications" (21). The model shall tackle (i) the complex nature of consumption decision-processes, as dependent on a broad range of societal influences, and (ii) the socio-political dimension of environmental concerns, represented by policy feedback. Hence, we aim to contribute to a theory of needs-based consumption and household satisfaction as a guideline for ecologically-oriented economic policy design.

Figure 1 displays the flow of the model in a formalised way and separates it into two spheres of influence: The model landscape is the environment the agents are acting in and which influences their consumption decisions. It is comprised of the government[1], prices, and consumption goods.

Households make autonomous consumption decisions to fulfil their heterogeneous needs, the satisfaction of which directly influence voting behaviour. Goods G_k^{eco} are structured into five broader goods categories $K \in \{foo, she, mob, goo, ser\}$, namely food, shelter, mobility, other goods, and other services (11). The ecological impact of a goods category is depicted as $eco = \{ci, cn\}$, where ci stands for carbon-intensive and cn for carbon-neutral, and is the only differentiating feature of otherwise homogeneous goods within each category k.

To maintain a certain degree of simplicity of our model, in its current state it does not include an endogenous firm sector that produces consumption goods. Hence, we infer fixed prices for each good, we do not model technological change or lock-in effects, and we assume fully adaptive supply in the short-term that always matches the current demand for (non-)pollutant goods. However, while the producer price for each good is constant over time, relative purchaser prices p_k^{eco} for each good category will be increased or decreased by the implemented policy measures. These endogenous changes to relative prices directly influence the affordability of carbon-intensive and carbon-neutral goods and thereby, due to households' budget constraints, also affect the quantities consumed of each goods category. Through this personal consumption, every agent fulfils their needs N_i^j (with $j \in J = \{bas, soc, lux\}$) to varying degrees and exhibits heterogeneity in terms of minimum acceptable and maximum obtainable satisfaction.

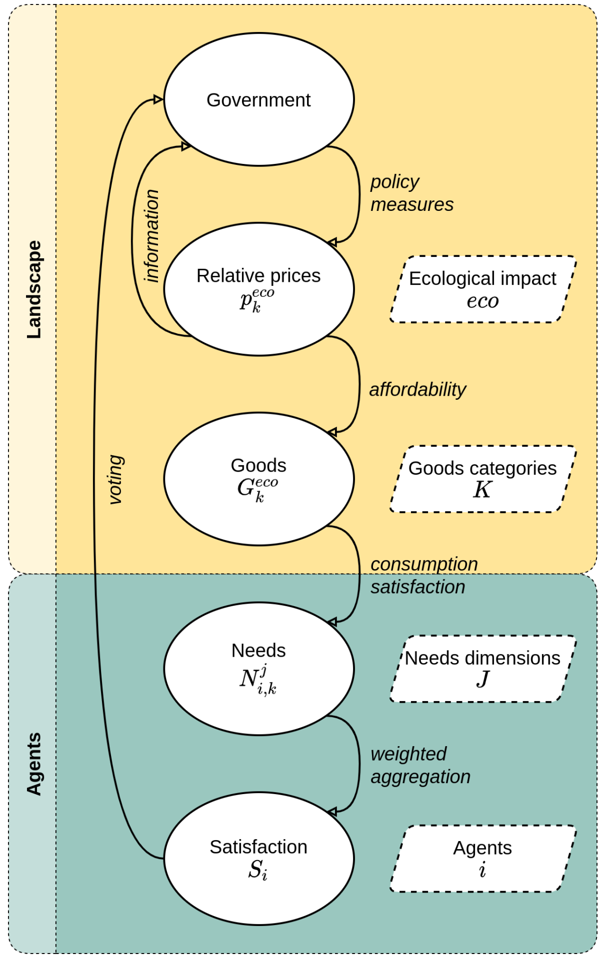

Fig. 1. Conceptual overview of the model.

Needs and consumption. We introduce households' heterogeneity in terms of sustainable consumption attitudes against the requirement of satisfying their non-substitutable needs (27).

Although needs research provides us with rich conceptualisations of specific human needs (e.g. 17; 7; 18), the link between needs and need satisfiers remains unclear, most likely depending on the complex interaction of multiple personal, social, and cultural factors (14). Thus, we refrain from modelling a direct need-to-consumption connection and instead apply a broader classification of needs that results in three hierarchical motivators for consumption. Figure 2 schematically illustrates the relation between these three needs dimensions and the five goods categories used throughout the model.

[1] For now, our model allows for only one political entity. There can be no regime change. Further, we assume a democratic state, allowing us to omit the dynamics of fundamental changes in the underlying political system.

First, agents try to cover their basic needs of health, safety and basic social participation, the satisfaction of which requires both direct satisfiers (a minimum amount of food, shelter, etc.) and the culture-specific means to achieve these factors (e.g. sufficient access to mobility or education). We deliberately exclude the potential impact of local infrastructure, regional differences in prices or availability, or personal preconditions. Hence, we assume the same constant basic consumption for all agents.

Once the basic consumption targets are met, agents engage in social consumption to satisfy needs related to social recognition and belonging. By observing the average non-basic consumption of their relevant peer group, they will establish their own peer reference value. The degree to which each agent copies their peers' consumption behaviour is mediated by a heterogeneous peer influence parameter PIP_i that is held constant over time.

Finally, agents spend their remaining disposable income according to their personal preferences and habits. This consumption is captured in the luxury needs category.

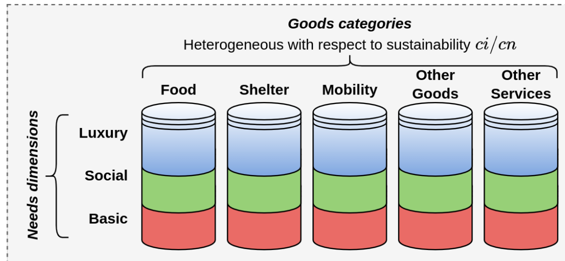

Fig. 2. Schematic display of the relations between the three needs dimensions and the five goods categories.

All goods categories can act as satisfiers for the three needs dimensions. No further allocation of more specific needs to goods categories is made. However, the needs can be satisfied by consuming either polluting (carbon-intensive) or ecological (carbon-neutral) goods. This ecological consumption decision depends on the relative prices of the goods G_k^{eco} and the household's budget constraint, as well as a personal sustainability consumption parameter SCP_i.

Satisfaction. After the disposable income has been spent on consumption across the goods categories to satisfy previously determined levels of individual needs, we can identify the current satisfaction levels of each agent in a two-step process. First, agent satisfaction within a goods category k is calculated with Equation 1.

$$S_{i,k} = \frac{C_{i,k}}{p_k} / N_{i,k} \; with \; N_{i,k} = \sum_{j \in J} N_{i,k}^{j} \tag{1}$$

Parts of agent satisfaction is shaped by emergent habits, which by definition evolve over time according to changes in consumption patterns. Thus, the functioning of habits in the model can be described as anchoring individual satisfaction to how much an agent has regularly consumed in the past. This directly manifests itself in the formation of luxury needs N_i^{lux} and by that also indirectly affects social needs N_i^{soc} to a lesser degree.

Second, the overall satisfaction level depends on the relative importance $w_{i,k}$ reflecting the share of net disposable income Y_i that is spent on consumption in goods category k. This can be formalised as $w_{i,k} = C_{i,k}/Y_i$ where $\sum_{k=1}^{K} w_{i,k} = 1$, which leads to the definition of Equation 2.

$$S_i = \sum_{k \in K} w_{i,k} S_{i,k} \tag{2}$$

At the end of each simulation step, the mean of these individual satisfaction levels is presented to the government as an aggregate metric to guide its policy-making process with the help of the aggregation function 3.

$$S = \frac{\sum_{i=1}^{n} S_i}{n} \tag{3}$$

Policies. The sustainability-orientated government faces a trade-off between its long-term goal of promoting environmentally friendly behaviour, requiring shifts in consumption and thereby damaging consumer satisfaction, and the necessity to be re-elected to continue sustainable policy-making.

It will therefore seek to promote sustainable consumption in each goods category by subsidising carbon-neutral variants G_k^{cn} and/or sanctioning carbon-intensive variants G_k^{ci}. To prevent satisfaction levels from falling below critical levels, it will monitor consumer reaction to policies introduced and, if necessary, relax policies again before an election. However, since the average satisfaction level can only act as a proxy for actual voting decisions, the election outcome cannot be accurately determined in advance. Hence, the governmental policies adapt to goods' relative price levels, households' consumption choices and resulting satisfaction levels, as well as changes in voting outcomes.

Voting. The simulation runs for a maximum of five legislature periods whereas each time step in the simulation corresponds to one month. After every few years, a governmental election will be held which is modelled as a binary yes/no vote. We use agents' current levels of need satisfaction[2] as a proxy to determine agents' voting behaviour and thus the outcome of the election.

$\text{vote}_i = \{ 1 \; if \; S_i > 0.5$
$0 otherwise$

$$vote = \frac{\sum_{i=1}^{n} vote_i}{n} \tag{4}$$

Once aggregate votes for the current government is equal to or falls below 50%, the current regime has failed and the simulation stops. Among other factors like time-lagged and cascading effects, the difference between observed mean satisfaction S from Equation 3 and the actual voting outcome *vote* from Equation 4 contributes to the government's uncertainty with regard to the feasibility of (recently) implemented policies. This momentary snapshot of agents' satisfaction levels might lead to delayed policy adjustments and reflect the inertia of the political systems (26).

Outlook

With this core model, we aim to illustrate the trade-off between human needs and political feasibility in the context of sustainable consumption. Ultimately, we aim to identify a potential set of policy-making strategies that might lead to a rapid transition towards eco-friendly consumption patterns without undercutting critical levels of public acceptance. We expect the results of the simulations to shed light on the interplay between the intensity of implemented policies and policymakers' speed of adaptation to public acceptance levels. Further extensions of the model might include (i) an explicitly modelled firms sector in the surrounding macro-framework, and (ii) learning governmental and household sectors with the ability to remember past occurrences and anticipate future behaviour of other entities.

[2] This modelling decision implies no household memory of past events, which is a drastically simplifying assumption of agent voting behaviour. In the future it is possible and desirable to add more sophisticated rules, e.g. a discounted memory function of satisfaction over time which might allow agents to vote in accordance with their long-term satisfaction levels.

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