Extended Abstract

Paper/Poster Title	**Promoting healthy and sustainable diets in Scotland: Insights from agent-based simulations**

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Abstract	***200 words max***

The poor healthiness and sustainability of Scottish diets keep causing concerns due to the limited success of policy interventions. While the trade-offs between different food characteristics considered by consumers as well as households' budgetary constraints can represent obstacles to promoting better diets, social networks are critical for disseminating influence and could thus help achieve more positive outcomes. We develop an agent-based model of consumers heterogeneous in their food preferences, who interact via household and workplace networks. Consumers maximise a multi-attribute utility function under budgetary and caloric constraints and update their preferences by observing others' choices. We assess how information campaigns, regulatory and market-based interventions affect the healthiness and sustainability of diets both during implementation and in the longer term. We find that campaigns have a persisting impact on stated preferences, but this is barely translated into dietary change. In turn, removal of undesirable meals from workplace canteens, taxation of undesirable food, and subsidisation of desirable options generate statistically significant benefits on diets, which nevertheless do not persist after these interventions end. Subsidies have a slight, persisting impact at high costs for public finances. The most effective approach is represented by a policy mix, but further simulations are needed to identify the best design.

Keywords	agent-based model; food preferences; healthy and sustainable diets; price intervention; social networks
JEL Code	**D91** Micro-Based Behavioural Economics: Role and Effects of Psychological, Emotional, Social, and Cognitive Factors on Decision Making; **Q18** Agricultural Policy; Food Policy

Introduction	***100 – 250 words***

The poor standards of the average Scottish diet in terms of healthiness and sustainability have caused public concern during the last 20 years. Improving diets at population level is challenging because food choices are affected by unconscious and complex trade-offs in terms of healthiness, sustainability, price, and other aspects such as convenience and taste. The various policies and interventions for improving diets have achieved only partial success, not least because they fail to simultaneously consider these trade-offs and the tight budgetary constraints especially for poorer households. In turn, social networks are critical for disseminating influence and establishing desired social norms, and can thus help achieve long-term behavioural change and improve the success of policy interventions, including in the food domain. The people we eat with and whose food choices we can directly observe, which here we call "eating networks", have the most influence on our food behaviours. Agent-based models

(ABM) are well suited to simulate the interactions of consumers with heterogenous preferences, deriving individual and population-level trajectories and long-term outcomes. Therefore, ABMs can be used to assess the impact of policy interventions without bearing the sizeable economic, environmental, and social costs of policy trials. We develop a theoretical ABM and calibrate it using real data from the Scottish population and insights from the literature. We design case studies corresponding respectively to the baseline dynamic of the model and to the implementation of information campaigns, regulatory and market-based interventions or a mix between them, aimed at promoting healthier and more sustainable diets.

Methodology | ***100 – 250 words***

We develop an ABM of consumers making food choices at home and at work (or at school) and calculate indexes of the sustainability and healthiness of their weekly diets in a baseline situation and after the introduction of different interventions. Each agent belongs to two networks (their household and, if employed, their workplace colleagues) and has idiosyncratic food preferences. Agents choose their meals three times a day by maximising a multi-attribute utility function under a budgetary and a minimum caloric constraint. The attributes of a meal are its price, convenience, taste, quantity, healthiness, and sustainability. At home, agents maximise the joint utility of all their household members, while in workplace canteens, they make individual choices. Their preferences evolve based on past choices and on the observation of others' food choices at work. Agents' uncertainty about the actual characteristics of a meal as well as systematic behavioural biases are included in the model. The agents are initialised as representative of the Scottish population in terms of demographic and socio-economic characteristics, and their preferences for specific attributes are assumed to follow distributions specific for their demographic and socio-economic group, derived from the literature. We construct a set of 50 real-world meal options, with attributes. The interventions tested include removal of unhealthy and unsustainable food choices from workplace canteens; information campaigns targeting the overall population; taxation of unhealthy and/or unsustainable meal choices; subsidisation of healthy and/or sustainable choices; and joint implementation of all of these.

Results | ***100 – 250 words***

For each scenario, we simulate 100 populations of 1,000 agents along one year. The interventions are introduced at week 11 and removed at week 45, to assess their impact both during implementation and after removal. After an initial period of "learning", agents' preferences and diets stabilise at levels more favourable to healthy and sustainable diets even in the baseline. A difference-in-differences approach is therefore adopted to assess the impact of interventions. Information campaigns affect preferences positively. Their impact on diets is limited due to trade-offs; nevertheless, it is more persisting than other interventions. Removing undesirable meals from canteens generates a short-term positive effect, larger for employed people. However, after removing the constraint, agents' diets do not differ significantly from before. Subsidisation generates the best outcome during implementation, and a small but statistically significant impact after removal. The monetary benefit for households is sizeable but comes at high costs for public finances (£145/person/year). Taxing unhealthy and unsustainable food generates short-term improvement, followed by progressive deterioration which, together with the rebound after withdrawal, results in worse-than-before outcomes. The tax generates a revenue of £34/person/year but the burden is relatively larger for large and deprived households. Finally, a mix of all of the above

interventions achieves the best outcomes. Despite a rebound after the measures are stopped, the increases in the sustainability and healthiness indexes are 0.3 and 0.7-point larger than in the baseline on a 100-point scale. Combining taxes and subsidies generates a cost for public finances (£139/person/year) and savings for consumers.

Discussion and Conclusion | ***100 – 250 words***

Our results suggest that to promote healthier and more sustainable diets, policymakers should strike a balance between different typologies of interventions. Suasive interventions (information campaigns) generate an impact on consumers' awareness and thus latent preferences for sustainable and healthy meals that persists in the long run, but that are seldom translated into consistent behaviour due to trade-offs with preferences for other food characteristics and budget constraints. Market-based interventions that change the relative cost of different meal options, or regulatory ones that remove unwanted options altogether, have a sizeable short-term effect, but this effect does not persist after the interventions are removed, with the partial exception of subsidies. Furthermore, the issues of cost effectiveness and fairness of the interventions must be considered. Although avoided healthcare costs are not factored in the simulations, we estimate the interventions' impact on public finances and on different types of households. Due to the redirection of consumers' choices towards subsidised products, subsidies can be costly for public finances, but benefit deprived and large households relatively more. For the opposite reason, the public revenue of a tax is comparatively small, and the burden is relatively larger for deprived and large households. Ideally, policymakers could combine population-level campaigns with regulatory interventions in social settings like workplace canteens, and use market-based interventions (taxes/subsidies) only for targeting extremely undesirable or very beneficial but unpopular food options. Further simulations are needed to identify the best policy designs and better appreciate network effects.