Label or taxes: Why not both? Testing nutritional mixed policies in the lab

Paolo Crosetto, Laurent Muller, Bernard Ruffieux

Journal of Economic Behavior and Organization 229 (2025) 106825

Contents lists available at ScienceDirect

Journal of Economic Behavior and Organization

journal homepage: www.elsevier.com/locate/jebo

Research paper

Label or taxes: Why not both? Testing nutritional mixed policies in the lab ☆

Paolo Crosetto *, Laurent Muller, Bernard Ruffieux

GAEL, Univ. Grenoble Alpes, INRAE, CNRS, Grenoble INP, France

A R T I C L E I N F O

Dataset link: https://osf.io/78x5f/

JEL classification:
C81
C91
D81

Keywords:
Nutritional policies
Labels
Price policy
Laboratory experiment
Nutri-Score

A B S T R A C T

We run an incentivized framed laboratory experiment to evaluate the interaction of labelling (Nutri-Score) and pricing policies (fat taxes and thin subsidies) on the food shopping of a sample of French consumers. Taxes and subsidies, designed to fit Nutri-Score, are differentiated according to their magnitude (large or small), and their salience (explicit or implicit). We exploit a difference-in-difference design, whereby subjects shop for real from a catalog of 290 products twice, first without any labelling nor pricing policy, and then a second time with one of five different combinations of labelling and pricing policies. Results show that: (i) when implemented alone, taxes and subsidies are less effective than labelling, especially when implicit and when small in magnitude; (ii) policies mixing pricing and labelling are strongly sub-additive; (iii) consumers would benefit from such policies in terms of expenditure at the expense of the State.

1. Introduction

Nutritional policies have been quite extensively tested in the laboratory. This has been particularly true for nutritional labels, that have been the object of a large and growing body of experimental research, using different labelling formats and experimental designs in different countries (for an extensive policy oriented review see Nohlen et al., 2022).

Alongside food labelling, pricing policies are increasingly advocated and implemented worldwide. One often debated instance is the soda tax (Seiler et al., 2021; Allcott et al., 2019). Positive and sustained effects have been registered in Mexico (Ng et al., 2019) and the USA (Silver et al., 2017); smaller but significant effects have been observed in France (Capacci et al., 2019). While the debate is not yet settled, the World Bank, in its 2020 report on obesity, is calling on poor and developing countries, which are most concerned by problems related to overweight and obesity, to strongly tax unhealthy foods (Popkin et al., 2020). According to this report, and to other voices from academia (Mytton et al., 2012), taxes should be set at 20% or higher to achieve substantial effects.

Such large-scale fiscal interventions directed at a wide range of food items have not yet been studied, let alone introduced. Europe's prevailing nutritional policy to date has been to rely on Front-of-Pack (FOP) nutritional labelling, and the debate has

☆ The paper was pre-registered at OSF, with DOI 10.17605/OSF.IO/R9Z4X. The experiments reported in this paper were financed by the French Ministry of Health. We would like to thank Aurélie Level and Mariane Damois for excellent lab assistance, and Adélaïde Fadhuile for her precious econometric advice. The results were presented at the 2019 Workshop on Healthy Ageing in Copenhagen, Denmark; in the plenary at the 2019 ASFEE in Dijon, France and at the 2022 183rd EAAE Workshop in Zagreb, Croatia; at the 2022 ASFEE in Lyon and at the 2022 Workshop on Behavioural Economics of Food at UCD, Dublin, Ireland. It was also presented at seminars in Dijon, Nanterre, JRC Bruxelles, Nice, Milan, Genoa and Turin. We thank attendees to all these meetings for insightful comments.

* Correspondence to: GAEL, BATEG, 1241 rue des Résidences, 38400 Saint Martin d'Hères, France.
E-mail address: topaolo.crosetto@inrae.fr (P. Crosetto).

https://doi.org/10.1016/j.jebo.2024.106825
Received 20 February 2024; Received in revised form 31 October 2024; Accepted 14 November 2024

Available online 19 December 2024

rather revolved around which labelling system to adopt (see for instance Cecchini and Warin, 2016; Ducrot et al., 2016; Crosetto et al., 2019; Muller and Ruffieux, 2020), with two of the main contenders being the French Nutri-Score and the Italian Nutrinform Battery (Carruba et al., 2021; Fialon et al., 2022; Touvier et al., 2021). Any future price intervention in Europe would then have to be implemented *on top* of existing labelling policies.

It is therefore crucial to understand how these two interventions would interact and what their combined effect would be. Experiments usually isolate interventions in order to obtain results that are valid *ceteris paribus*. Nevertheless, the overall effect of a policy mix does not necessarily reflect the sum of the effects of its parts. In general we cannot expect effect sizes of different interventions as found in the literature to be simply additive, as this would result in combined effects of incredible magnitude (Szaszi et al., 2022).

To answer these questions we design a framed experiment which compares, under ceteris paribus conditions, the relative impacts on food purchases of labelling policies, pricing policies and combinations of the two.

One would hope that policies are super-additive, that is they enhance each other; or that at least they are additive — that their combined effect is the sum of their individual effects. But strict additivity might be too optimistic, and we might be in the realm of complementarity — the total is less than the sum of its parts, but still better than each of the parts taken separately. Worse, two policies may be incompatible, or substitutes: choose one or the other, but not both.

The reasons for possible or observed complementarities of nutritional policies may also be explored. Labelling and pricing policies are expected to impact purchasing behaviour, mainly through three channels. Firstly, the variation in relative prices affects the expenditure optimization problem. In order to allocate their monetary resources as efficiently as possible, consumers will find taxed goods less attractive, while subsidized goods more so. Secondly, the provision of credible signals reduces information asymmetry, thus giving consumers the means to make educated choices that best serve their own short- and long-term well-being. Finally, conveying a prescriptive message can nudge indecisive consumers towards more virtuous options. Stating what is good and what is bad affects consumers' decision heuristics, and can even shape their preferences if these are not strongly rooted. While the 'optimisation' channel is clearly the preserve of pricing policies, the 'information' and 'prompt' channels are rather the preserve of labelling policies — except for the case of a transparent and explicit pricing policy, i.e. one that signals price variations and the reasons for them; in such a case consumers can deduce the nutritional value of products from price changes, thus leaving the channel for change through information operational.

Our experiment further explores which channel of change – monetary incentive, information or prescription – is the most effective in improving consumers' diets. To do so, on top of a fixed labelling policy we explore pricing policies along two dimensions that are likely to impact the channels through which the policy operates, their *magnitude* and *salience*.

The labelling system tested is the Nutri-Score, developed by Julia and Hercberg (2017). Adopted in France in 2017 and later in Germany, Spain, the Netherlands, Belgium, Switzerland and Luxembourg, the Nutri-Score is a colour-coded front-of-pack label that ranks foods into five categories (from A, healthiest, to E, less healthy, green to red) according to their nutritional content. The Nutri-Score not only provides consumers with the tools they need to easily discriminate between products based on their nutritional quality, but it also conveys an injunctive norm designed to nudge consumers towards green and away from red products.

All pricing policies tested here are strictly aligned with Nutri-Score — i.e., they consist in subsidizing healthy products in categories A and B and taxing unhealthy products in categories D and E, while leaving C products untouched.

Along the *magnitude* dimension, to gauge change induced by monetary incentives, we test a large intervention, entailing price changes up to 20%, and a small, sand-in-the-gears pricing policy consisting of negligible price variations of up to 2 euro cents.

Along the *salience* dimension, we test an implicit policy where only the new price set by the policy is posted, and an explicit policy where the initial price is crossed out and presented alongside the new price. Compared with implicit, the explicit pricing policy gives salience to monetary incentives (Chetty et al., 2009). It also provides the necessary information to enable consumers to discriminate between good (subsidized) and bad (taxed) products.

Within this framework, the paper makes four contributions. First, we rank labelling and pricing policies, when tested separately, according to the extent of their impact on the nutritional quality of consumers' shopping baskets.

Second, we measure the impact of the combination of labelling and pricing policies on the nutritional quality of consumers' shopping baskets. The objective is to check whether such policy mix produces better or worse results than each policy on its own. The mix can either have positive, complementary effects, or negative, substitute effects. When complementary, we check whether pricing and labelling policies are simply additive, sub- or super-additive.

Third, we assess the impact of each policy (labelling, pricing and policy mix) on the economic cost of consumers' daily food purchases. Switching to healthier products can be costly. The simultaneous application of subsidies for healthy products and taxes for unhealthy products may, depending on consumers' responsiveness to the policy, offset the additional costs or even reduce the shopping expenditure. We moderate the results according to the income level of consumers. If low-income consumers have less healthy diets and are less sensitive to price variations, they could end up paying more tax and receiving fewer subsidies, making the pricing policy regressive, as documented in Muller et al. (2017).

Fourth, we replicate Crosetto et al. (2019) Nutri-Score results. Those earlier results, which showed the effectiveness of the Nutri-Score on purchasing behaviour, having been obtained prior to the introduction of Nutri-Score in France, we test whether these results remain valid two full years after Nutri-Score adoption and gradual diffusion.

Experiments are particularly useful for testing policy interventions *ex ante*, i.e. before they are implemented in the real world, and for isolating their effects. To our knowledge, this experiment is the first to compare, non-hypothetically and without confounding effects, the impacts of pricing and labelling interventions and the combination of the two on the nutritional quality of full shopping baskets. Experiments studying combined labelling and pricing policies are extremely scarce in the literature. Waterlander et al.

(2013) first used a three-dimensional web-based supermarket in the Netherlands to test three levels of price reduction each coupled with three different labels. Results show that price effects overshadow food labels, but these results rely on a small number of observations per treatment group (from 9 to 15) and refer to purchase intentions rather than actual purchases.[1] More recently, Faccioli et al. (2022) conducted a large survey-based experiment in the UK. Respondents stated their purchasing intentions successively without policy intervention, then with the Nutri-Score and last with a nutrition tax applied (from 5 to 45% price increase on products in classes D and E of the Nutri-Score). While such an experimental design cannot isolate the effects of price and labelling, the results show that the introduction of a tax on top of an in-place Nutri-Score increases the impact on stated purchases. Finally, three similar Canadian studies (Acton and Hammond, 2018; Acton et al., 2019, 2020) used a between-within design where participants were assigned to one specific labelling condition and sequentially completed several shopping tasks with different tax levels each time. Based on actual purchases of a drink or snack, the results show no interaction effect between price and labelling interventions, but effects are modest.

Overall, our results imply that prescription has a larger impact on the nutritional quality of the shopping than monetary incentives and information. Pricing interventions have a weaker impact than labelling, when tested in isolation. Salience is important, as explicit price policies have a larger impact than implicit, and large interventions are needed to spur change. When looking at the policy mix, results show that policies are strongly sub-additive, to the point that the nutritional effect of mixed policies is not statistically different from that of labelling alone. However, consumers benefit financially (at the expense of the State) from pricing policies by receiving more subsidies than taxes. With the exception of the implicit pricing policy, which makes it difficult to recognize price changes, consumers are nonetheless maintaining their spending levels by re-optimizing the composition of their baskets. Finally, we perfectly replicate the results of our previous experiments on the impact of Nutri-Score after two years of adoption of the label in France, showing the robustness of the Nutri-Score impact and indirectly validating our methods.

2. Methods

The experimental design is the same as Crosetto et al. (2019), from which we also reuse data of two benchmark treatments. Subjects shop for food in an experimental grocery shop set up in our laboratory. We compare the relative impact of various policies and policy mixes on subjects' purchases using a Difference-in-Differences (DiD) approach: each subject shops twice, first without and then with a given policy in place. We thus measure the individual impact of each intervention within subjects, and then compare their impacts between subjects.

More specifically, subjects in the lab are asked to shop for two days' worth of food for their household on a catalog composed of 290 products across 39 food categories — details of the catalog are provided in Appendix B. They are aware that their shopping choices have real consequences: they know that we hold about one product in four in stock in a nearby room, and that they have to buy the intersection of their choices and our stock. Since they cannot know in advance what is in stock, they have to treat each choice as potentially binding. After completing the first shopping phase, subjects are invited to participate in the second, unannounced, shopping phase. Before the start of this last phase, they are informed (i) of the nature of the intervention in accordance with the condition to which they have been randomly assigned and (ii) of the fact that only one shopping phase, drawn at random at the end of the experiment, will be taken into account for the purchases.

2.1. Treatments

We run five different treatments, and compare them to two benchmark conditions, for which we reuse the data of Crosetto et al. (2019). The first is the Benchmark treatment from Crosetto et al. (2019), a no-change scenario where subjects shop twice with no change to the catalog. The second benchmark is the Nutri-Score treatment from Crosetto et al. (2019), that was run over the same products and with the same methods, but in a context where Nutri-Score was not previously known to subjects as it had not yet been introduced in France.

The five treatments vary along two dimensions: the presence or absence of the Nutri-Score and the presence or absence of a given form of a pricing policy. Pricing policies vary along two dimensions: magnitude and salience. To vary magnitude, we adopt a small (± 1 or 2 Euro cents) or large (± 10 or 20%) price change. To vary salience, price changes can be implicit (only the new, modified price is shown) or explicit (the new price is shown alongside the old, crossed out price). All pricing policies are perfectly aligned with the Nutri-Score: products labelled A (that is, healthiest) see a 20% (2 cents) and B a 10% (1 cent) price decrease; prices of C products are unchanged, and prices of D see a 10% (1 cent) and E (least healthy) a 20% (2 cents) increase in price, respectively in the large and small price intervention. We do not explore the full range of possible interactions of price magnitude, price salience and labelling, but limit ourselves to the five treatments we find more sensible to test the impact of mixed policies (see Table 1).

The Nutri-Score 2019 treatment replicates the Nutri-Score 2016 treatment, three years later and two and a half years after the nation-wide introduction of Nutri-Score in France. This allows us to test the robustness of our earlier results. The Implicit price and Explicit price treatments are run using the large price intervention (± 10 or 20%) in order to increase the likelihood of detecting potential differences when manipulating the salience of the price change. The policy mix of labelling and pricing policy is tested in two treatments. NS + small price combines the Nutri-Score with small price intervention, just dust in the gears of the order or 1 or 2 eurocents. NS + large price combines the Nutri-Score with the large price intervention, in line with the World Bank's recommendations (Popkin et al., 2020).

[1] van der Molen et al. (2021) used the same protocol to determine whether the impact of nudging and pricing strategies was moderated by consumers' personal characteristics. They found no differentiated effects.

Table 1
Treatments, sample size and data sources.

Treatment	Label	Price policy	Price change	N	Campaign
Benchmark 2016	No	No	None	120	2016
Nutri-Score 2016	Yes	No	None	116	2016
Nutri-Score 2019	Yes	No	None	71	2019
Implicit price	No	Implicit	Large	76	2019
Explicit price	No	Explicit	Large	83	2019
NS + small price	Yes	Explicit	Small	78	2019
NS + large price	Yes	Explicit	Large	78	2019

2.2. Measures

We observe subjects shopping twice. The first basket, without any intervention, allows us to set a benchmark for the shopping behaviour of each subject. The second basket allows us to assess, within subjects, policy-driven changes with respect to the baseline basket. The comparison of individual changes across treatments allows us to cleanly assess, by exploiting difference-in-differences, the effect of different policies by controlling for the heterogeneity of individual preferences. We have two measures of interest: nutritional value and expenditure.

We adopt as our nutritional measure the Nutrient Profiling Model developed by the UK Food and Standard Agency (Rayner et al., 2009, henceforth FSA score). This score is computed for each product by assigning negative points for salt, saturated fatty acids, calories, and sugar, and positive points for fibre, fruit & vegetable content and proteins. The score ranges from −15 to 35, with lower numbers indicating better overall nutritional quality.

We compute the aggregate nutritional score for each shopping basket, by adding the FSA score of each product p and normalizing by 2000 Kilocalories. That is, for each subject i, for each basket $j \in [1,2]$, we compute

$$FSA_{ij} = \frac{\sum_p Kcal_{pij} \cdot FSA_{pij}}{\sum_p Kcal_{pij}},$$

in which the index pij denotes product p in basket j for subject i. We are mainly interested in the *change* of this measure across shopping baskets, ΔFSA

This measure gives us a single, continuous variable to assess the nutritional quality of the whole shopping basket. Nonetheless, it relies on two assumptions: that the FSA score correctly assesses the nutritional value of a shopping basket, and that a normalization by calories does not introduce bias. The FSA is widely used in epidemiological studies (Julia et al., 2015; Ducrot et al., 2015; Julia et al., 2014), and its value as a nutritional score is well documented. Normalization by energy content has the advantage of delivering results that are easily interpreted as one day of consumption for an average adult, and to anchor the results to the basic measure of human energetic needs.

Our measure of expenditure is the sum of the prices of all items chosen in each shopping basket by a subject, normalized by 2000 Kilocalories. That is, for each subject i, each basket $j \in [1,2]$, we compute

$$expenditure_{ij} = 2000 \cdot \frac{\sum_p Price_{pij}}{\sum_p Kcal_{pij}},$$

in which the index pij denotes product p in basket j for subject i. We are mainly interested in the *change* of this measure across shopping baskets, $\Delta expenditure$.

We estimate treatment effects using a linear regression with standard error clustered at the subject level.[2] We use the same estimation strategy for both our dependent variables, the variation in score FSA and in total expenditure for 2000Kcal across shopping baskets. Formally, we estimate

$$Y_{itj} = \alpha + \beta \cdot basket_{it} + \sum_{c=1}^{6} \lambda_c \cdot treatment_i + \sum_{c=1}^{6} \delta \cdot treatment_i \times basket_{it} + \varepsilon_{it},$$

in which Y_{itj} represents two distinct variables (denoted by j), score FSA and expenditure, for subject i and basket t, α identifies the average nutritional value of the first basket for the reference treatment, β the change in the second basket, λ_c the difference in the first basket for each treatment c with respect to the reference treatment, and the interaction yields the difference-in-difference impact of each treatment with respect to the reference. We chose the Benchmark treatment from 2016 where no policy was applied between the first and the second basket as reference.

To investigate the impact of the results for different income levels, we use two variables coding income by consumption unit[3]: a fine-grained variable with 8 levels (from less than 1000 €/month to more than 8000 €/month, in intervals of 1000 €), and a more coarse aggregation of the above variable in three levels (lower than 2000 €, between 2000 and 3000 €, higher than 3000 €).

[2] Results are exactly identical under the pre-registered fixed-effect estimation, see Appendix A.

[3] We follow the French Statistical Office (INSEE) definition. Family income is divided by a number equal to one for the first adult in the household, plus 0.5 for any additional person aged 14 or older, and 0.3 for any additional person under 14.

The former has the advantage of being more fine-grained, but the disadvantage of having very few observations for some levels (e.g. 8000+, one observation); the latter is more coarse, but more evenly distributed (142 low, 79 medium and 94 high-revenue subjects). Using these two variables, we look at changes in expenditure and in nutritional value of the baskets for different income levels.

We also analyse expenditure from the angle of price change indexes. To do so we use both Laspeyres ($\mathcal{L}$) and Paasche ($\mathcal{P}$) price indexes. Denoting P_{tj} the price, Q_{tj} the quantity bought of each item j by subject i in basket t, the indexes are:

$$\mathcal{L}_i = \frac{\sum_j P_{2j} \cdot Q_{1j}}{\sum_j P_{1j} \cdot Q_{1j}} \quad ; \quad \mathcal{P}_i = \frac{\sum_i P_{2i} \cdot Q_{2i}}{\sum_i P_{1i} \cdot Q_{2i}}$$

The indexes allow us to summarize the aggregate change in price of the shopping across baskets, for each subject. The Laspeyres index is computed with respect to the pre-policy basket, and as such does not take into account changes in the composition of the basket, allowing us to observe the impact of price policies *if subjects do not make any adjustment*; the Paasche index is computed with respect to the post-policy basket, and takes into account behavioural change and response to incentives.

We compute the indexes for each subject, and then analyse them both globally by treatment, and specifically by income bracket, to check whether the result of Muller et al. (2017) showing that labelling policies have regressive characteristics replicate in our sample.

2.3. Laboratory procedures

Each subject participated to one of 25 experimental sessions held in our experimental laboratory at Grenoble Institute of Technology (Grenoble INP). Randomization into treatments was obtained by letting subjects freely choose to which of the 25 sessions they wanted to participate; treatments were then randomly assigned to sessions, unbeknownst to participants. Upon entering the lab, subjects drew a random ID number to make their data anonymous. They took place at one of 20 computerized cubicles. An experimenter read aloud the instructions[4] displayed both on two large screens and on each subject's individual screen. Questions were answered publicly.

Subjects received 35 € for their participation. They shopped using a paper catalog and a software reproducing an e-shop environment, programmed with a custom PhP-based application.[5] The baseline paper catalog contained information about each products' price, quantity, price per kg or per litre, as well as a frontal picture of each product. The e-shop environment gave access to the nutritional table and ingredients' list, that is, to the information usually found on the back of pack.

After the first shopping phase, subjects were asked to start again from a new catalog containing the same products but subject to a specific policy (labelling, pricing, or both). Subjects were instructed on all details of the specific policy that would be imposed on their second shopping. In particular, in price policy treatments we clearly state that price changes were connected to a nutritional assessment of the food items. The precise instructions for each treatment can be found in Appendix C. Subject were informed that one of the two shopping phases would be later drawn at random to be binding for the actual purchases.

Once every subject had finished the second shopping phase, all subjects went through a socio-demographic questionnaire and were then called individually to buy the items in stock from among those they had chosen. Subjects left with a bag of grocery shopping and spent on average 7 euros. The experiment lasted about one hour and fifteen minutes.

3. Results

This section reports the results of the pre-registered analyses. A simplified version of the pre-registered hypotheses is given in Table 2. The full hypotheses and the rest of the pre-registration are available at the OSF page of the paper https://osf.io/r9z4x. Exploratory analyses are provided below, in Section 4. We venture out of the pre-registered path to offer two extra analyses. First, we provide more insights as to what exactly changed in the behaviour of our subjects, using descriptive statistics to assess the policy-induced changes in quantity, prices and Nutri-Score category between the two shopping baskets by treatment. Second, we compute the costs that the different price policies would imply for the government, should the tested nutritional tax policies be implemented, and assuming the effects measured in the laboratory generalize. All data and analyses for both pre-registered and exploratory analyses are available on the OSF page and in the linked githubrepository.

3.1. Sample

386 subjects from the general population of Grenoble were recruited from the GAEL subject pool and through advertisements in the local media and social networks. We specifically targeted subjects used to shopping in supermarkets (as opposed to farmers' markets), and invited only the person most regularly in charge of the shopping for each household. Based on effect sizes known from Crosetto et al. (2019), we pre-registered 400 subjects, 80 per treatment. Due to last-minute cancellations, final attendance ranged from 71 to 83 subjects per treatment. Data from Crosetto et al. (2019) Benchmark and Nutri-Score treatments collected

[4] The English, text version of the original French slides is available on appendix C. The original slides are available at the OSF page of the paper https://osf.io/78x5f/.

[5] Screenshots of the custom e-shop application are available on Appendix D.

Table 2
Simplified version of the pre-registered hypotheses.

Domain	#	Hypothesis
Labelling	1	Nutri-Score improves nutritional quality as in Crosetto et al. (2019)
Price policy	2	Explicit price policy has larger impact than implicit
Policy mix	3	Mix has larger impact than label or price alone
	4	Mix is sub-additive: smaller impact than labels + price alone
	5	Mix with larger pricing policy has larger impact than small
Expenditure	6	Overall: pricing policies decrease subjects' expenditure
	7	Distributional impact: pricing policies are regressive (Muller et al., 2017)

Table 3
Demographics of the sample, overall and by treatment.

value	overall	Benchmark	NutriScore 2016	NutriScore	NS + large price	NS + small price	Implicit price	Explicit price	Chi2 p-value
Age									
20–35	36.12	21.67	27.59	38.03	43.04	37.18	52.63	44.58	
35–50	39.17	54.17	47.41	38.03	27.85	34.62	27.63	32.53	0.00044
>50	24.72	24.17	25.00	23.94	29.11	28.21	19.74	22.89	
Education									
Less than high school	20.55	32.50	23.28	8.45	21.52	16.67	19.74	13.25	
High school	10.27	10.00	17.24	7.04	11.39	6.41	7.89	8.43	0.00099
University or more	69.18	57.50	59.48	84.51	67.09	76.92	72.37	78.31	
Gender									
Female	72.55	78.33	77.59	64.79	64.56	84.62	65.79	66.27	0.00835
Male	27.45	21.67	22.41	35.21	35.44	15.38	34.21	33.73	
Income									
<2000€	33.87	41.67	39.66	22.54	35.44	33.33	31.58	25.30	
2000-3000€	33.87	34.17	25.86	39.44	34.18	37.18	34.21	36.14	0.19422
>3000€	32.26	24.17	34.48	38.03	30.38	29.49	34.21	38.55	
Profession									
Blue collars	2.09	4.17	0.86	2.82	2.53	0.00	1.32	2.41	
Executives	22.47	19.17	13.79	32.39	27.85	26.92	14.47	28.92	
Handicraft	2.25	2.50	1.72	1.41	2.53	1.28	3.95	2.41	0.50623
Professionals	11.24	11.67	12.07	12.68	8.86	10.26	9.21	13.25	
Unemployed	6.58	8.33	5.17	5.63	7.59	5.13	7.89	6.02	
White collars	55.38	54.17	66.38	45.07	50.63	56.41	63.16	46.99	

Percentages by category for each variable and treatment. The last column reports results of a χ^2 test across treatments.

in 2016 (235 subjects) complement the data from this new campaign and provide valuable reference points for comparison. This sample came from the same subject pool and was recruited with identical procedures. We ensured that no subject having taken part in 2016 participated in 2019. No subject was allowed to participate twice within the 2016 and 2019 campaigns. Since no subject met the pre-registered exclusion criterion (buying zero items in one of the two shopping carts), we did not exclude any subject from the analysis.

Table 3 reports subjects' demographics, as well as their breakdown by treatment and randomization checks. Overall, our subject pool is heterogeneous in terms of age, occupation and income per consumption unit. The sample over-represents women and higher educated people. The high proportion of women might be a consequence of our requirement that subjects be regularly in charge of grocery shopping. The large share of higher-educated subjects stems from our lab's location within the city in a sector featuring large R&D firms and two universities.

Randomization checks show that treatments do not significantly differ on income and profession. They do differ in age structure, education and gender. The difference in age and gender is due to the data pulled from the 2016 campaign; within the 386 subjects recruited in 2019, neither age (χ^2 p-value = 0.598) nor education (χ^2 p-value = 0.414) show any significant difference across treatments. The share of females is higher in the 2016 campaign, but also in the NS + small price treatment.

3.2. Results overview

Table 4 reports the results of linear difference-in-difference estimation, separately for the change in FSA score (ΔFSA) and the change in expenditure (ΔExp) between the first and second shopping baskets. Fig. 1 complements Table 4 by graphically showing the estimated parameters and the confidence intervals estimated by the same regression, when compared to the Benchmark. In the following, all tests are Linear Hypothesis Tests on the estimated coefficients from this regression; these allow us to expose the significance of contrasts between treatments that are not readily observable from the regression table. Appendix A reports, for

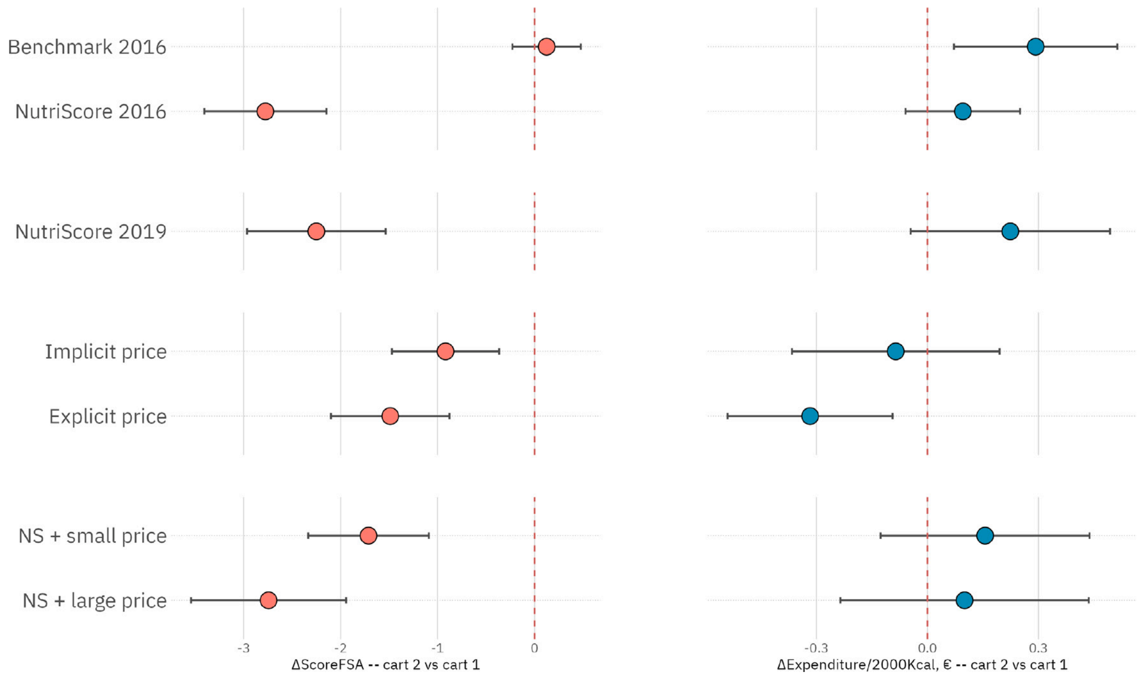


Fig. 1. Regression coefficient plot, economic and nutritional changes, basket 2 *vs.* basket 1. Coefficients and confidence intervals of linear regression of Table 4.

Table 4
Difference-in-difference linear regression, standard errors clustered by subject.

	ScoreFSA	Expenditure
Intercept	5.177 (0.275)***	4.978 (0.128)***
Basket 2	0.124 (0.180)	0.096 (0.079)
Implicit large price change	−1.680 (0.487)***	0.578 (0.225)*
Explicit large price change	−2.245 (0.471)***	0.646 (0.241)**
NutriScore 2016	−0.439 (0.422)	0.259 (0.197)
NutriScore and large price change	−0.985 (0.470)*	0.653 (0.236)**
NutriScore and small price change	−2.428 (0.467)***	1.059 (0.260)***
NutriScore 2019	−2.080 (0.445)***	0.871 (0.233)***
Basket 2 ×Implicit large price change	−0.918 (0.282)**	−0.317 (0.114)**
Basket 2 ×Explicit large price change	−1.488 (0.311)***	−0.086 (0.143)
Basket 2 ×NutriScore 2016	−2.775 (0.320)***	0.293 (0.113)**
Basket 2 ×NutriScore and large price change	−2.743 (0.407)***	0.100 (0.171)
Basket 2 ×NutriScore and small price change	−1.712 (0.317)***	0.156 (0.144)
Basket 2 ×NutriScore 2019	−2.250 (0.364)***	0.224 (0.137)
Num.Obs.	1242	1242
R2	0.168	0.047
R2 Adj.	0.160	0.037
AIC	6472.7	4905.1
BIC	6544.5	4976.9
RMSE	3.24	1.72
Std.Errors	by: subject	by: subject

*** : $p < 0.001$; ** : $p < 0.01$; * : $p < 0.05$.

completeness, descriptive statistics in Table A.1 and the full data with a raincloud plot in Figure A.1. Results are exactly identical if we follow the pre-registered fixed-effect regression or if we run a random effect model without and with individual controls, as reported in Tables A.2 and A.3 also in Appendix A.

3.3. Labelling only

The introduction of Nutri-Score improves the nutritional quality of baskets. In the 2019 data, ScoreFSA decreases by −2.25 points from basket 1 to basket 2, strongly significant (Linear Hypothesis Test on the regression coefficient (LHT), $\chi^2 = 42.16, p < 0.001$).

Results largely replicate the 2016 campaign of Crosetto et al. (2019), validating Hypothesis 1. 2019 subjects start from a significantly better basket in terms of nutritional value than the 2016 subjects (4.74 FSA points in the unlabelled shopping basket

1 in 2016 *vs.* 3.10 in 2019, LHT, $\chi^2 = 11.977, p < 0.001$). Yet the changes induced by Nutri-Score are identical in sign, similar in magnitude and dispersion, and not significantly different across the two samples (LHT, $\chi^2 = 1.617, p = 0.203$). Three years later, and despite an overall nutritionally better initial basket, the effect of the Nutri-Score in our laboratory is qualitatively and quantitatively the same.

3.4. Pricing only

Both pure pricing interventions improve the nutritional quality of the baskets. FSA score significantly decreases by −0.92 points (LHT, $\chi^2 = 6.173, p = 0.012$) with implicit pricing and −1.49 points (LHT, $\chi^2 = 13.437, p < 0.001$) with explicit pricing.

The nutritional impact of the explicit price policy is greater than that of the implicit policy. Though the difference is only weakly statistically significant ($\chi^2 = 2.912, p = 0.088$), the gap in size of effects is large, of the order of 60% (−1.49 *vs.* −0.92). The results therefore weakly validate Hypothesis 2 and are in line with the findings of Chetty et al. (2009) in the context of explicit vs. implicit VAT on sale prices that making pricing policy salient improves its effectiveness.

3.5. Labelling *vs.* pricing

Nutri-Score generates larger improvement in nutritional quality of baskets than both pricing policies. Compared with implicit pricing, the difference is large (−2.25 FSA points *vs.* −0.92) and strongly significant (LHT, $\chi^2 = 12.068, p < 0.001$). Compared with explicit prices, the difference is smaller (−2.25 *vs.* −1.49) and only weakly significant (LHT, $\chi^2 = 3.528, p = 0.06$).

3.6. Policy mix

Support for Hypothesis 3, that the policy mix has a larger impact than single interventions, is limited. The policy mix has an impact with respect to the no-policy benchmark both in the case of the large (−2.78 FSA points, LHT $\chi^2 = 31.309, p < 0.001$) and the small pricing policies (−1.72 FSA points, LHT $\chi^2 = 17.123, p < 0.001$). While the extent of these improvements is larger than that of pricing alone, it is not statistically different from that of labelling alone, which reinforces the idea of a primacy of labelling over pricing.

In the case of large price policies, the policy mix is statistically indistinguishable from labelling alone (−2.25 for labelling, −2.78 for large mix, LHT $\chi^2 = 1.038, p = 0.308$), but it has a larger impact than pricing alone (−1.49 *vs.* −2.78, LHT $\chi^2 = 7.941, p < 0.001$). The FSA point estimate for the policy mix with small price changes is also not significantly different from that for labelling alone (−1.71 *vs.* −2.25, LHT $\chi^2 = 1.724, p = 0.189$). We have no clear counterfactual for small price, since we did not test a pure small price policy, but it is telling that the point estimate for the policy mix with small prices is statistically not distinguishable than the impact of a pure *large* price policy (−1.71 *vs.* - 1.49, LHT $\chi^2 = 0.378, p = 0.539$).

Within the policy mix, though, a large price intervention has a significantly stronger effect than a small one, supporting Hypothesis 5 (−2.78 *vs.* −1.71, LHT $\chi^2 = 5.269, p = 0.022$).

Finally, in accordance with Hypothesis 4, the cumulative effect of the two policies is sub-additive. Indeed, the policy mix has a strongly significant lower impact than the sum of the pure pricing and labelling policies (−2.78 *vs.* −(2.25 + 1.49), LHT $\chi^2 = 37.173, p < 0.001$). Nevertheless, such extreme sub-additivity was not expected. While sub-additivity was anticipated (Szaszi et al., 2022), our intuition was that the marginal impact of an additional policy would be nonetheless positive. As presented above, data show that adding a pricing policy on top of labels has no additional impact; and that adding a small price intervention even reduces the impact, even though not significantly so.

3.7. Expenditure: overall impact

In order to tackle Hypothesis 6, according to which pricing policies would decrease subjects' expenditure, we run two different sets of comparisons: we compare treatments involving pricing policies to treatments not involving any pricing policies, first in absence of labels (Implicit price and Explicit price *vs.* Benchmark), and then in presence of labels (NS+small price and NS+large price *vs.* Nutri-Score).

In absence of labels, the evidence is mixed: in the Implicit price treatment, where price changes were not made salient, the expenditure decreased with respect to the Benchmark treatment (−0.32 € between cart 1 and 2 *vs.* +0.10 €, LHT, $\chi^2 = 5.406, p = 0.02$); but it did not for the Explicit treatment, where the price change was made salient (−0.09 € *vs.* +0.10 €, LHT, $\chi^2 = 0.841, p = 0.359$).

In presence of labels, price changes do not seem to impact expenditure. Compared to the situation where labelling is implemented alone (Nutri-Score treatment), neither a small (+0.16 € *vs.* +0.22 €, LHT $\chi^2 = 0.172, p = 0.678$) nor a large (+0.10 € *vs.* +0.22 €, LHT $\chi^2 = 0.429, p = 0.512$) price intervention have any further effect on expenditure.

This small to non-existent change in expenditure comes in a situation in which subjects were on average net receivers of subsidies (see analysis in Section 4). This points to the possibility of subjects re-optimizing, i.e. exploiting the net subsidy by buying more expensive (and healthier) products, keeping on the same budget line, especially in presence of labels that make the move towards healthier food easier.

The Laspeyres and Paasche indexes show that there are two channels through which expenditure can decrease. First, all Laspeyres indexes, that are computed on the reference, pre-policy basket, are lower than one (t-test, all p-values < 0.001) for all treatments

Table 5
Mean expenditure and net subsidy by income level.

	N	Small price change			Large price change		
		Expenditure (€)	Net subsidy (€)	Share (%)	Expenditure (€)	Net subsidy (€)	Share (%)
Coarse income level							
< 2000	142	24.15	0.09	0.39	23.94	1.18	5.35
2000–3000	79	24.76	0.09	0.34	23.65	1.43	6.54
> 3000	94	41.20	0.10	0.26	30.82	1.29	5.00
Fine-grained income level							
< 1000	39	18.98	0.07	0.35	24.09	0.96	4.63
1000–2000	103	26.04	0.10	0.40	23.88	1.26	5.62
2000–3000	79	24.76	0.09	0.34	23.65	1.43	6.54
3000–4000	55	41.84	0.12	0.30	30.63	1.44	5.44
4000–5000	25	36.06	0.07	0.20	30.79	1.16	4.37
5000–6000	10	50.16	0.09	0.18	34.67	0.90	2.11
6000–7000	3	–	–	–	33.45	1.48	3.67
> 8000	1	–	–	–	0.58	0.15	25.86

involving a price change. This means that the average basket is somewhat healthy, as even without taking into account adjustment by subjects the mean price of the *reference* basket decreases if you apply the price policy. Second, Paasche indexes are significantly lower than Laspeyres for all treatments involving a price change (t-test, all p-values < 0.015). This means that the treatment did induce movement in subjects' choices away from taxed and towards cheaper, subsidized products. Impacts are larger for the large policy and behavioural response is less pronounced when price changes are implicit (see Figure A.2 in Appendix A).

3.8. *Expenditure: distributional impact*

As documented in Muller et al. (2017), Hypothesis 7 claims that lower income subjects would be negatively impacted by price policies as they would end up paying more taxes and receiving less subsidies. To ascertain whether there is a significant gradient in revenue, we restrict attention to all treatments implementing pricing policies, irrespective of the presence or absence of a label, and divide them according to the extent of the policy. One treatment, NS + small price, features the ±1/2cents policy; three treatments (NS + large price, Implicit and Explicit) feature the ±10/20% policy. Table 5 reports the overall results for the two income variable (coarser and fine-grained) and over the two different price policies.

Expenditure generally increases, at least weakly, with income — which is a welcome sanity check for our data. For the coarse classification, high income subjects spend more than middle and low income for both large and small price changes (t-tests, all p < 0.001); for the fine-grained classification, subjects with the lowest income spend significantly less than the highest income category with a number of observation that still allow for meaningful testing (5000–6000 €) for the small price change (t-test, p < 0.001) but differences are not significant for the large price change (t-test, p = 0.12).

Net subsidies do not seem to reflect income as much (for a breakdown of net subsidies by treatment, see below Section 4). They are positive for *all* income levels, for both income variables and both price interventions, and the data show no particular robust pattern. For both income classifications, no significant difference is found on any contrast, neither for the net subsidy nor for the weight of this subsidy as a share of total expenditure (t-test, all p-values > 0.12).[6]

The analysis of Laspeyres and Paasche indexes by income category yields a similar null result. Using the coarse aggregation, all Laspeyres indexes for all income groups for all treatments are significantly lower than 1 (t-test, all p-values < 0.018), meaning that there is no income group that has a *reference*, pre-policy basket that has enough nutritionally bad items as to result in an increased price level *absent any behavioural adjustment*. Behavioural change seems to be guided by the presence of a label: all Paasche indexes in treatments with NutriScore are significantly lower than Laspeyres, irrespective of the income group (t-test, all p-values < 0.011). On the other hand, in absence of labels *no* Paasche index is lower than Laspeyres (t-test, all p-values 0.098) with the exception of the low income group of the Explicit Price treatment (t-test, p-value = 0.002). Most importantly, no index (Laspeyres nor Paasche) is different across income groups, for any treatment (t-tests, all p-values > 0.06).

We clearly cannot replicate, in this specific context, the results of Muller et al. (2017) and we do not find support for a regressive nature of labelling nor price policies.

4. Exploratory analyses

Policy impacts on shopping patterns

While above we analysed the policy impact on aggregate nutritional and economic measures for each basket, here we provide more micro data on how policies impacted quantities, prices, and nutritional breakdown by Nutri-Score category of the products bought.

[6] This battery of tests was not pre-registered. For such complex interactions and such clear null results we find that it is preferable to display Table 5 and related tests than the pre-registered three-way interacted regression, that is hard to read and interpret — results are the not impacted by the change in methods.

Table 6
Policy-induced changes in quantity and mean price.

	Number of items			Mean pre-subsidy price per item		
	Basket 1	Basket 2	Δ	Basket 1	Basket 2	Δ
Benchmarks						
Benchmark 2016	21.58	21.25	−0.34	1.70	1.75	0.05
NutriScore 2016	17.87	17.52	−0.35	1.68	1.69	0.01
Labelling						
NutriScore	15.82	15.46	−0.35	1.75	1.77	0.01
Policy mix						
NS + small price	16.42	16.36	−0.06	1.75	1.75	0.01
NS + large price	17.01	17.17	0.15	1.75	1.80	0.05
Price policy						
Explicit price	14.65	14.46	−0.19	1.72	1.76	0.04
Implicit price	16.38	15.90	−0.48	1.68	1.60	−0.08

Table 7
Mean difference in number of products, caddy 2 vs caddy 1, by treatment and NutriScore category.

	NutriScore category					
	A	B	C	D	E	None
Benchmarks						
Benchmark 2016	−0.20	−0.01	0.00	0.04	−0.05	0.01
NutriScore 2016	1.11***	0.61***	−0.36*	−1.24***	−1.08***	0.03
Labelling						
NutriScore 2019	1.21***	0.57***	−0.41	−0.97	−1.08*	−0.17
Policy mix						
NS + small price	1.03*	0.46*	−0.19	−0.90***	−0.74	0.04
NS + large price	1.31***	0.30	−0.07	−1.00	−0.72	−0.18
Price policy						
Explicit price	0.55*	0.52	0.00	−0.73	−0.64	−0.27
Implicit price	0.23	0.17	−0.02	−0.38	−0.17	−0.34

p-values: *** < 0.001, ** < 0.01, * < 0.05.

Table 8
Mean expenditure and net subsidy by treatment.

treatment	Mean expenditure	Net subsidy	Share of expenditure
NS + small price	28.44 €	0.09 €	0.35%
NS + large price	28.82 €	1.65 €	6.46%
Explicit price	23.95 €	1.37 €	6.27%
Implicit price	25.47 €	0.8 €	3.82%

Table 6 shows the mean individual difference in the number of items bought and their average *pre-subsidy* price, in the two baskets by treatment.

No difference is significant (t-test, all p-values > 0.19), but the general pattern shows that subjects did spend slightly more per item when in presence of subsidies (4 to 5 cents, for an average price per item in the catalog of 1.96 €), while buying slightly less.

Table 7 shows the mean individual difference in the number of products in basket 2 with respect to basket 1, across all treatments and for each Nutri-Score category. For each treatment but the Benchmark, the number of A and B products increased, and the number of D and E products decreased. Changes are almost always significant for A-products, sometimes for B-products, and haphazardly for lower-ranked products. Increased significance for the 2016 campaign with nearly identical mean changes most likely stems from sample size, about 25% larger in 2016 per treatment.

Cost–benefit analysis

Subjects were on average net receivers of subsidies (Table 8) — which means that the price policies are net costs for the state. This squares with the fact that on average subjects improved their nutritional quality with all policies, without changing the number of items purchased (Table 6) but moving along the NutriScore gradient (Table 7). Their magnitude was limited, though, ranging from 0.3% of the total expenditure for small price interventions to 3–6.5% for the large price interventions.

If we assume that the nutritional quality, expenditure, and fiscal costs observed in our laboratory carried out to everyday shopping and were sustained for a whole year, we can compute both the nutritional gain and the fiscal cost – total yearly government

Table 9
Cost–benefit analysis of the different policies.

	Household	Government
	Nutritional change	Yearly cost per household
Label only		
NutriScore	−2.13 (2.67)	0€ (0)
Price only		
Implicit price	−0.79 (1.89)	130.3 € (132.01)
Explicit price	−1.36 (2.32)	233.3 € (177.28)
Policy mix		
NS + large price	−2.62 (3.23)	279.8 € (230.48)
NS + small price	−1.59 (2.3)	15.9 € (10.45)

expenditure on subsidies minus total yearly fiscal gains from taxes – for a representative family for a year (Table 9). Each of these is in itself a heroic assumption, so these results are to be taken for what they are — extrapolations based on our lab sample able to give us at most a rough order of magnitude.

The implementation of a large price policy on top of Nutri-Score – the only policy that achieves a better nutritional improvement than Nutri-Score alone – results in a non-significant amelioration in scoreFSA for an average annual cost for the treasury per household of about 280 € — hardly a viable option.

5. Limitations

The laboratory makes it possible to study mixed nutritional policies *ex-ante*, an otherwise daunting task. Running Randomized Controlled Trials (RCTs) in the field is extremely costly, especially if one wants the tested intervention (price, labelling, both) to cover the entire product range. Furthermore, price changes up to 20% are likely to be far greater than what private sector partners would allow. In many respects, laboratory studies are therefore a valid and sometimes, especially for price changes, the only method available to study *ex-ante* large-scale nutritional policies and their interactions in a controlled manner.

This study relied on a non-student sample of heterogeneous consumers and put them in a situation as similar as we could muster to real-life shopping. The context of choice (online shopping), the task (food shopping for their household) and the expenditure (actual purchases of actual products at market prices) are similar to those in real life. The two aforementioned studies on Front-of-Pack labelling, one in the laboratory (Crosetto et al., 2019), the other in the field (Dubois et al., 2020), offered a rare opportunity to provide evidence that experimental results carry over to the field. The ranking of labelling formats tested (including the Nutri-Score) generating the healthiest baskets found in the lab was identical to that found in the large RCT ran in 60 French supermarkets.

The use of the laboratory, nonetheless, has a number of limitations.

Despite thorough framing, the exercise remains artificial, especially in some parts of the design. In particular, the choice of selling only $\frac{1}{4}$ of all products, while justified by logistical arguments, is rather artificial. Moreover, changing prices in the lab leads to changes in relative convenience with the outside world, and could lead subjects to withhold consumption in the lab to collect more money to spend outside of the lab. We took great care in drafting a price policy that was on average neutral (see Appendix B) and we have no evidence of changes in the number of items bought; moreover, the "pay 1 in N" paradigm is largely used across experimental economics (Charness et al., 2016), with no particular bias identified. Nonetheless, both features could limit external validity.

Moreover, we observe that the lab can act as a magnifying glass, emphasizing the treatment effects. Even though Crosetto et al. (2019) and Dubois et al. (2020) found the same order of performance for their labelling formats, the effect size was much (13 to 35 times) lower in real shops. We might be looking at an upper bound of the potential policy effect here.

Much larger observed effects in the lab could be due to a host of reasons. One is excessive attention and focality. In the laboratory, participants are focused on the task at hand and have time to assimilate all the stimuli that come their way during the experiment. Moreover, while this experiment, based on a 'before-after intervention' structure, is ideal to isolate treatment effects, it places even more emphasis on the policy. As a result, the laboratory is likely to boost the impact of the policy. But it may also distort the relative impact of the competing policies tested, as it could favour those that require more effort — those are bound to perform poorly in the field, but could stand a chance in the lab. A second one is demand effect: subjects could infer the aim of the experimenter, especially in a design that requires us to describe labels at length, something that does not happen outside the lab. We control for this using difference-in-difference, and by exposing all subjects of all treatments (but the Benchmark) to extensive explanations of similar length. Still, we cannot strictly rule out that demand effect was identical across treatments.

Finally, it is not certain whether the results obtained in a laboratory study can be sustained over the long run. Subjects might have an initial strong reaction to a new policy, but gradually revert to their pre-intervention habits. It might also be that price changes have a less immediate impact than labels, but are more important in the long run when budget constraints come into play for consumers. Our experiments, like any one-shot laboratory experiment we can think of, cannot provide reliable data on the long-term effect of policies — this is work that has to be done with panel data.

6. Discussion

Until new behavioural policy tools, such as nudges and boosts (Chetty, 2015; Grüne-Yanoff, 2018) become mainstream and as long as analog information on the product is preferred at the point of sale by shoppers to qr-codes or mobile apps, pricing and labelling will remain the two main policy interventions to change food purchasing behaviours. Pricing and labelling affect choices mainly through three channels. First, by modifying relative prices, rational consumers readjust their choices in order to optimize their preferences according to their budget constraints. Second, by indicating which products are healthy and which are not, uninformed consumers reconsider their preferred items. Third, by issuing a normative message, volatile consumers revise their preferences.

Our study examines the impact on food purchase of pricing and labelling policies when implemented alone and when combined, providing valuable insights on the relative importance of the three channels.

The first result is that labels have a significantly larger impact than price changes. There are good arguments for why the difference could have gone either way. The relative impact between pricing and labelling policies depends on which channel of change (monetary incentives, information or prescription) triggers the most behavioural responses. If subjects act like informed *homo œconomicus*, they should be insensitive to the information provided by labels or to their prescription; they should simply reassess their optimal basket according to relative price changes. The superiority of labelling over pricing suggests that consumers are not fully informed or that they have preferences that may be impacted by normative signals.

Our result holds with the NutriScore, that has been shown elsewhere to be the most impactful label in the lab (Crosetto et al., 2019) and in the field (Dubois et al., 2020), and within the limited and arbitrary set of price policies tested; it is hence not clear whether this result would generalize to other labels and other fiscal interventions.

Nonetheless, we have tested a rather large intervention (−/+20%) and following earlier results by Chetty et al. (2009) we made it explicit and salient; in both accounts, it is likely that real-world price policies, if any, will be more limited and less focal than the one we tested. Overall, we hence show that a strong labelling policy that is already in force in several parts of the world can outperform a price policy stronger than the ones likely to be applied in practice.

The second result concerns the interaction effects between pricing and labelling policies. The nutritional impact of mixed policies is unexpected: coupling the large-scale pricing policy with the Nutri-Score does not result in any significant change compared with labelling alone. Contrary to our expectations, labelling and pricing policies are not even sub-additive, the marginal contribution of pricing on top of labelling being negligible and not significant. Coupling the Nutri-Score with a small-scale pricing policies, based on token gestures, could even lead to reduce the impact of labelling (echoing results of Gneezy and Rustichini, 2000).

The final set of results looks at the impact of pricing and labelling on expenditure levels. Only the implicit pricing policy has significantly reduced the cost of the consumer basket. Yet consumers have been the net beneficiaries of all pricing policies (implicit, explicit, mixed with labels), buying more subsidized items than taxed ones. It would therefore seem that consumers acted at least partially as *Homines œconomici* and have re-optimized given the new prices, striving to maintain their initial budget line, by compensating for the subsidies by buying more expensive products. This did not happen in the implicit price treatment, likely because subjects could no re-optimize when the price changes were not clearly spelled out nd focal. In contrast to Muller et al. (2017), we find no differential impact of policies by income group, and no regressive effect: the price policies applied do not have any noticeable distributional effect.

Overall, we can propose some tentative conclusion from our study with respect to three channels for behavioural change identified above: maximization, information, and normative messages. Consumers do not seem to be perfect maximizers: although consumers showed price sensitivity, and seemed to partly re-optimize their choices in presence of price changes, monetary incentives had a weaker impact than colour-coded information. Provision of information also cannot be said to be the main channel. In fact, in our setting the explicit pricing policy contains just as much information as the Nutri-Score, being fully aligned with it. By observing price variations for each item, consumers can accurately deduce the health class (A to E) of each item, just as with the Nutri-Score. Yet the impact remains far less important. That leaves us with the final channel for change: prescription. With its colours ranging from green to red, the Nutri-Score label provides a normative assessment of the health quality of food. Consumers seem therefore to be responsive to the prescription. If so, then behavioural policies might have a bright future ahead of them.

The limits of this study notwithstanding, some clear policy recommendations can still be formulated. The magnitude of the difference in impact between labelling and pricing policies observed in the laboratory is sufficiently large to confidently recommend (well-designed) labelling as the preferred policy option. In line with the literature on the efficacy of labelling (Muller and Ruffieux, 2020; Storcksdieck Genannt Bonsmann et al., 2020), the format of the label should be prescriptive in order to maximize its efficacy.

Any implemented price policy should be large-scale and salient. Unlike labelling, pricing policies can also be driven by fiscal considerations, either to fund the public treasury or to stimulate consumption. This study focuses solely on balanced pricing policies where, on the basis of the Nutri-Score classes, taxes on unhealthy products are theoretically offset by subsidies on healthy products. Within this framework, consumers fiscally benefit from these policies at the expense of the State (Table 8), with no sign of revenue progressivity nor regressivity.

As for policy mixes involving labelling and pricing, the nutritional gain seems to be too small to offset the substantial cost (Table 9). Coupling a pricing policy with an existing labelling like the Nutri-Score would, though, offset the possible extra expenditure incurred by following the Nutri-Score recommendations, making it cheaper for consumer to sustain in time a healthier consumption.

All in all, within the limits of our design we can confidently say that labels appear as a more cost-effective nutritional policy tool than price intervention or mixed label-price interventions, at least in the short run.

Table A.1
Overview of nutritional and economic results: descriptive statistics.

	ScoreFSA				Expenditure			
	Cart 1	Cart 2	Difference	*p*-value	Cart 1	Cart 2	Difference	*p*-value
Benchmarks								
Benchmark 2016	5.18 (3.01)	5.3 (2.93)	0.12 (1.96)	0.557	4.98 (1.4)	5.07 (1.38)	0.1 (0.86)	0.058
Nutri-Score 2016	4.74 (3.43)	2.09 (3.47)	−2.65 (2.84)	<0.001	5.24 (1.6)	5.63 (1.65)	0.39 (0.86)	<0.001
Labelling								
Nutri-Score	3.1 (2.95)	0.97 (3.07)	−2.13 (2.67)	<0.001	5.85 (1.64)	6.17 (1.97)	0.32 (0.95)	0.006
Policy mix								
NS + small price	2.75 (3.34)	1.16 (3.18)	−1.59 (2.3)	<0.001	6.04 (2)	6.29 (2.02)	0.25 (1.06)	0.028
NS + large price	4.19 (3.37)	1.57 (3.31)	−2.62 (3.23)	<0.001	5.63 (1.75)	5.83 (2.18)	0.2 (1.34)	0.3
Price policy								
Explicit price	2.93 (3.48)	1.57 (3.25)	−1.36 (2.32)	<0.001	5.62 (1.86)	5.63 (1.94)	0.01 (1.09)	0.342
Implicit price	3.5 (3.51)	2.7 (3.32)	−0.79 (1.89)	0.001	5.56 (1.62)	5.33 (1.45)	−0.22 (0.71)	0.016

Means (st. dev.) for each variable. P-values: difference between baskets 1 and 2, Wilcoxon signed-rank test.

Table A.2
Fixed and Random intercept model with and without controls, ScoreFSA. Standard error clustered by subject.

	Fixed effects	Random intercept	Random intercept controls
Intercept		5.177 (0.274)***	6.280 (0.594)***
Cart 2	0.124 (0.179)	0.124 (0.178)	0.124 (0.178)
Implicit large price change		−1.680 (0.485)***	−1.809 (0.486)***
Explicit large price change		−2.245 (0.468)***	−2.338 (0.464)***
NutriScore 2016		−0.439 (0.420)	−0.437 (0.416)
NutriScore and large price change		−0.985 (0.467)*	−1.031 (0.467)*
NutriScore and small price change		−2.428 (0.464)***	−2.456 (0.465)***
NutriScore 2019		−2.080 (0.442)***	−2.156 (0.442)***
Cart 2 ×Implicit large price change	−0.918 (0.281)**	−0.918 (0.280)**	−0.918 (0.280)**
Cart 2 ×Explicit large price change	−1.488 (0.310)***	−1.488 (0.309)***	−1.488 (0.309)***
Cart 2 ×NutriScore 2016	−2.775 (0.320)***	−2.775 (0.319)***	−2.775 (0.319)***
Cart 2 ×NutriScore and large price change	−2.743 (0.406)***	−2.743 (0.405)***	−2.743 (0.405)***
Cart 2 ×NutriScore and small price change	−1.712 (0.316)***	−1.712 (0.315)***	−1.712 (0.315)***
Cart 2 ×NutriScore 2019	−2.250 (0.363)***	−2.250 (0.361)***	−2.250 (0.361)***
Age			−0.024 (0.011)*
Female			−0.061 (0.284)
SD (Intercept subject)		2.743	2.735
SD (Observations)		1.758	1.758
Num.Obs.	1242	1242	1242
R2	0.879		
R2 Adj.	0.755		
R2 Marg.		0.167	0.172
R2 Cond.		0.757	0.758
R2 Within	0.352		
R2 Within Adj.	0.345		
AIC	5307.7	6052.1	6059.1
BIC	8525.9	6134.0	6151.4
ICC		0.7	0.7
RMSE	1.24	1.34	1.34
Std.Errors	Custom	Custom	Custom
FE: subject	X		

Declaration of competing interest

Declare not to have any conflict of interest to declare upon submission of our manuscript.

Appendix A. Supplementary tables and figures

See Figs. A.1 and A.2 and Tables A.1–A.3.

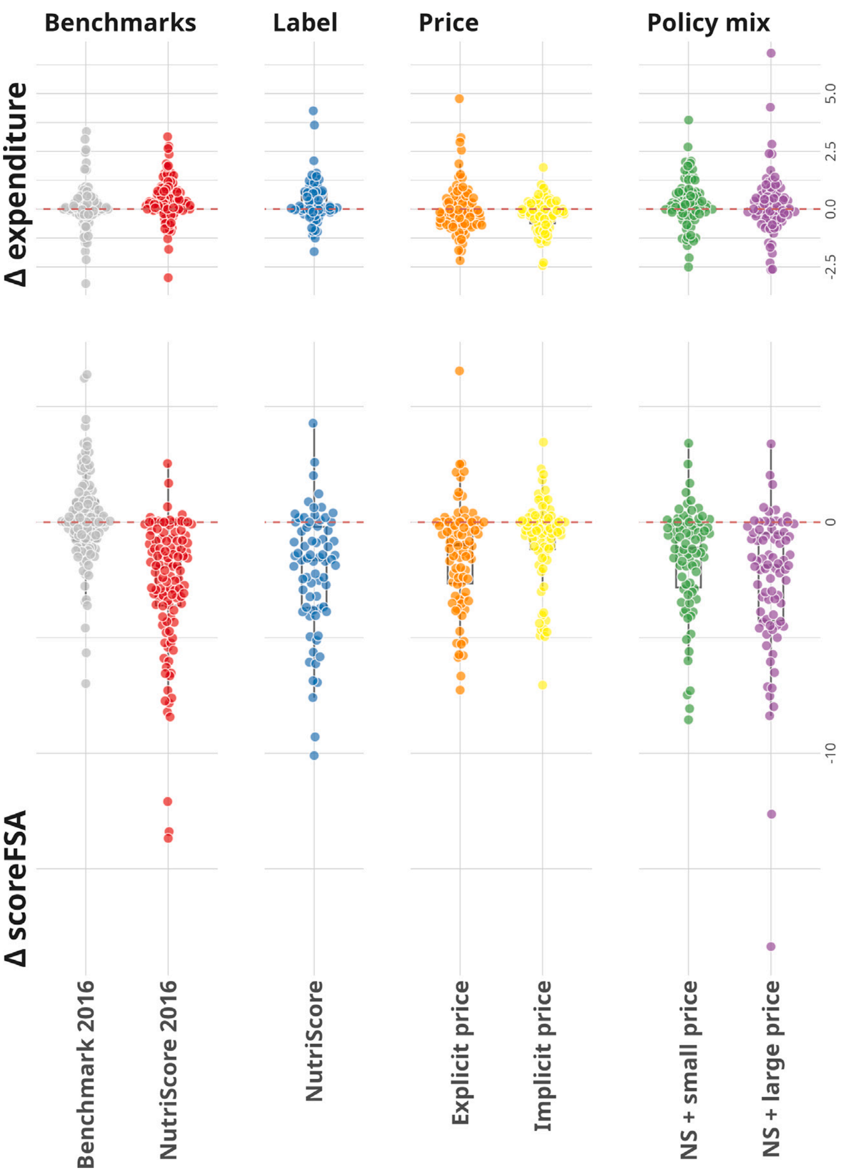


Fig. A.1. Full distribution and data by treatment.

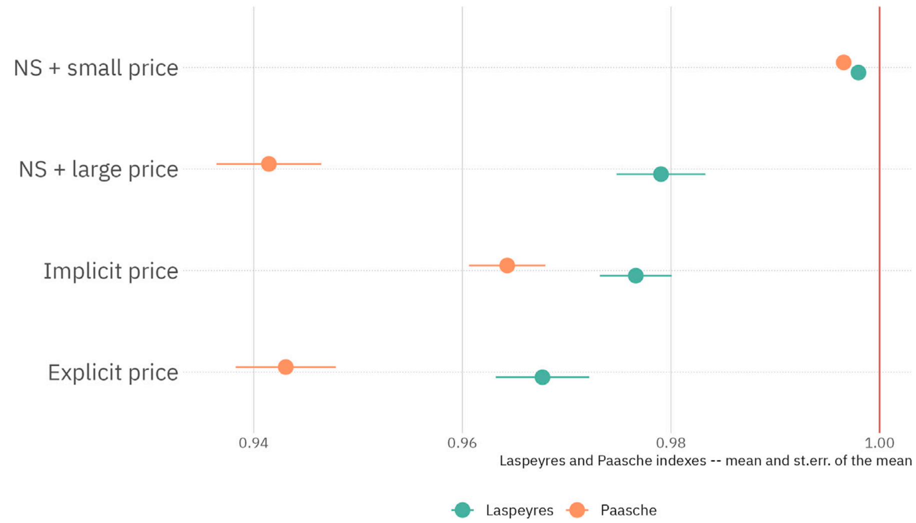


Fig. A.2. Mean and standard error of the mean, Laspeyres and Paasche indexes of price change, basket 2 vs basket 1, for all treatments involving price changes.

Table A.3
Fixed and Random intercept model with and without controls, Expenditure Standard error clustered by subject.

	Fixed effects	Random intercept	Random intercept controls
Intercept		4.978 (0.127)***	3.337 (0.348)***
Cart 2	0.096 (0.079)	0.096 (0.078)	0.096 (0.078)
Implicit large price change		0.578 (0.224)*	0.782 (0.219)***
Explicit large price change		0.646 (0.240)**	0.803 (0.235)***
NutriScore 2016		0.259 (0.196)	0.259 (0.193)
NutriScore and large price change		0.653 (0.234)**	0.760 (0.231)**
NutriScore and small price change		1.059 (0.258)***	1.071 (0.258)***
NutriScore 2019		0.871 (0.231)***	1.014 (0.227)***
Cart 2 ×Implicit large price change	−0.317 (0.113)**	−0.317 (0.113)**	−0.317 (0.113)**
Cart 2 ×Explicit large price change	−0.086 (0.143)	−0.086 (0.142)	−0.086 (0.142)
Cart 2 ×NutriScore 2016	0.293 (0.112)**	0.293 (0.112)**	0.293 (0.112)**
Cart 2 ×NutriScore and large price change	0.100 (0.171)	0.100 (0.170)	0.100 (0.170)
Cart 2 ×NutriScore and small price change	0.156 (0.143)	0.156 (0.143)	0.156 (0.143)
Cart 2 ×NutriScore 2019	0.224 (0.137)	0.224 (0.136)	0.224 (0.136)
Age			0.030 (0.007)***
Female			0.426 (0.137)**
SD (Intercept subject)		1.587	1.543
SD (Observations)		0.697	0.697
Num.Obs.	1242	1242	1242
R2	0.923		
R2 Adj.	0.845		
R2 Marg.		0.047	0.093
R2 Cond.		0.846	0.846
R2 Within	0.059		
R2 Within Adj.	0.048		
AIC	3007.5	4184.9	4165.7
BIC	6225.6	4266.9	4258.0
ICC		0.8	0.8
RMSE	0.49	0.51	0.51
Std.Errors	Custom	Custom	Custom
FE: subject	X		

Appendix B. Experimental instructions

The original instructions were made up of a Power Point slideshow, using several visual cues to make them appealing and easy to understand for our subjects. The French version of the slideshow is available at the OSF page of the paper https://osf.io/78x5f/. Here we provide a translation of all the words, plus the most relevant pictures.

General instructions

Welcome. This experiment is run by the Grenoble Applied Economics Laboratory (GAEL), part of the University Grenoble-Alpes (UGA). This study is financed by the Ministry for Social Affairs, Health and Womens' Rights.

The study is about individual food consumption behaviour. Instructions will be given to you as we go along. During the whole session, you will have to take some simple decisions. Nonetheless, should you have any difficulty or misunderstandings, do not hesitate to ask.

In order to protect your privacy during the session and in data analysis, you have been assigned a code. No data allowing us to identify you will be collected. Thus, it will be impossible for us to link your replies and decisions to your name. Data will be kept for statistical analysis and publication, but always in their anonymous format.

Communication between participants is not allowed, nor are comments about what should or should not be done during the experiment. Keep concentrated on your own computer screen and keep silence for the whole session. If you have a question, feel free to raise your hands and ask anytime.

You will see on your desk an envelop containing 32 € in cash, rewarding you for your participation. This sum is yours to keep. During the experiment, you will have the opportunity to buy some products. It is important that you understand why and how you will be able to shop.

We ask you to shop because we want to observe your actual shopping behaviour and not just your shopping intentions. As behavioural scientists, we know that intentions can differ from actual purchasing decisions. Our guiding principle is simple: put you in a real shopping situation. You will have to buy some products, that you will have chosen yourself. In no circumstance our research group makes profits out of the eventual sales. The products will be sold at supermarket prices, as recorded by us on October 5th, 2016. You will discover these prices later in the experiment.

This study is composed of several phases. After the start of each phase, instructions for the following phase will be given. A new phase will start only after all participants have completed the previous phase. This session will not exceed one hour and thirty minutes.

Phase 1: food shopping

During this first phase, you will be shopping for food. You will have to compose your basket in the same way you would do in a supermarket. In order to observe your real shopping behaviour, your decisions will have real implications (namely, the purchase of some products).

Imagine you are in the only shop open today. Please do not take into account the shop you usually go to. You will have to shop for the coming 2 days (no week-end) for your household, choosing along the products available in our shop. Please think that your cupboards at home are empty. Think that they contain only some basic products: butter, flour, oil, spices, coffee, tea, seasoning, water, alcohol, wine, sugar, vinegar, sauces. These products will not be on sale here.

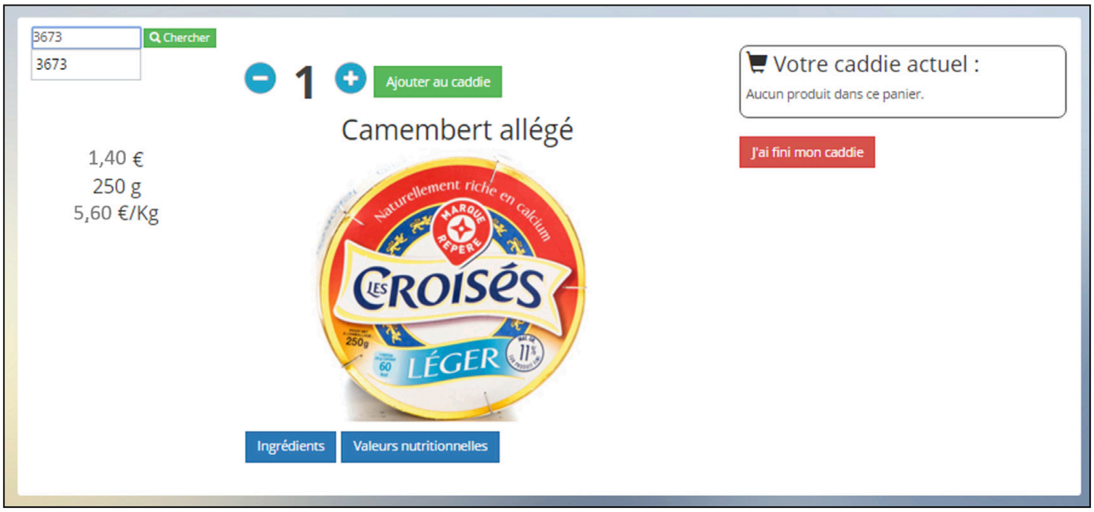
In order to fill your shopping basket, you will be able to choose among 290 food products, presented to you in the paper catalogue that was just handed over to you.[7] Each page of the catalog contains products of a specific category. Each category is composed of 3 to 9 products. A table of contents is available at the beginning of the catalog.

On the screen, you will see this page:

In order to select a product and display it on the screen, you can use the barcode scanner available on the desk in front of you. Pass the scanner over the barcode of the product and press the button. Should you meet any difficulty with the scanner, you can manually type the 4-digit product code in the search bar and click on 'search'.

7 [see B for a sample page of the catalog in each treatment]

Once you selected the product, it will be shown on screen as seen in a supermarket shelf, showing its front of pack.



You will see price, price per kilogramme or litre, and its weigh or volume. The prices shown have been recorded in a Grenoble area supermarket. You can click on the buttons “Ingredients” and “Nutritional values” to access the information that you normally find on the back of pack.

If you click on “Ingredients” you will access the substances or food additives used in the production of that food item. These ingredients are present in the final product in a more or less transformed state. On your screen (as on backs of pack), ingredients are ranked according to their relative importance in the product recipe. As the lax dictates, the ingredients potentially resulting in intolerance or allergies must be highlighted. Here, they will be written in ALL CAPS.

If you click on “Nutritional values” on your screen (as on backs of pack) you will find the nutritional values, expressed for 100 grams of product. These values will not be available for some products (fruits, vegetables...), as for these products the law does not impose their display.

Once you have selected the product you are free to choose a quantity, as you would do in normal shopping. Once you have chosen its quantity, you can add it to the basket by clicking on “add to basket”. Even after you have added the product to your basket you can change its quantity using the buttons “+” and “−” and then confirming with the button “Change quantity”. You can remove the product from the basket clicking on “Remove from basket”. Once you have finished to fill your basket, you can click on “I finished my basket”.

Your decisions will have real implications. In order to observe your actual shopping behaviour, your decisions will have real implication (namely, the purchase of some products). This will be done in the following way:

- in another room we store about one quarter of the 290 products displayed in the catalog. In order not to influence your choices, you will not know which products we store or not.
- at the end of the experiment we will identify the products of your basket that we stock; in all likelihood, a quarter of the products you chose.
- you will have to buy these products. For example, if your basket contains 20 products, you will likely buy 4 or 5 of them, for a cost of some Euro. You will leave the room with these products. Please note that the products are sold at the prices shown on the catalog.

Any questions?

[During the shopping task, the overhead projectors showed a reminder of the main features of the task. This is its text:] Reminder: you shop for the next 2 days for your household. You are free to choose the products and quantity you prefer; to spend the amount you prefer. You can retrieve the information that you would find on the backs of packs, namely ingredients and nutritional information, on screen.

Phase 2: food shopping, a second basket

Your task. We ask you now to compose a second shopping basket. We will shortly hand you a new shopping catalog. It contains the same products. We remind you that you have access to the nutritional values and ingredients of the products by clicking on the corresponding buttons below the product image.

Your shopping. Just one of the two baskets will be taken into account for the product purchases at the end of the experiment. The binding basket will be randomly drawn at the end of the experimental session.

Why a new shopping basket? The Ministry of Health has introduced a simplified, front-of-pack graphical representation: the Nutri-Score. The Nutri-Score helps you to make better choices, for your own health, when buying food products. Our study aims at assessing the impact of a price policy associated to the Nutri-Score

[*Implicit Price and Explicit Price*:] We test with you the impact of **price changes**. For each product, public health researchers have developed a nutritional score based on the density of elements that you need more of (fibre, protein, fruit, vegetables) and elements you need less of (calories, saturated fatty acids, sugar and salt). Each product has been ranked on a 5-level scale that go from the most nutritionally good to the least nutritionally good product. The prices vary according to this table:

Nutritionally worse			Nutritionally better	
Price decrease		No price change	Price increase	
-20%	−10%	0%	+10%	+20%

[*Nutri-Score*:] We test with you the impact of **Nutri-Score without price changes**. Nutri-Score is a label that informs you about the nutritional quality of a product, using a letter associated with a colour-code. For each product, public health researchers have produced a score that takes into account its contents in terms of nutrients that ought to be maximized (fibre, proteins, fruits & vegetables) and those that ought to be limited (energy, saturated fatty acids, sugar and salt). Each product is ranked on a 5-level scale, going from the most nutritionally valid product (A, dark green), to the least nutritionally favourable product (E? dark orange).

Examples:

Vegetable ravioli Product 1 is ranked **B** because it contains a sizeable quantity of vegetables and fibres, but also because it contains little of nutritional elements that ought to be limited as salt or saturated fatty acids.

Cheese ravioli Product 2 is ranked D because it contains more calories than product 1, more salt and saturated fatty acids, less vegetables and fibres.

The Nutri-Score scale looks like this:

[*Nutri-Score + small price* and *Nutri-Score + large price*:] We test with you the impact of **Nutri-Score with additional price changes**. Nutri-Score is a label that informs you about the nutritional quality of a product, using a letter associated with a colour-code. For each product, public health researchers have produced a score that takes into account its contents in terms of nutrients that ought to be maximized (fibre, proteins, fruits & vegetables) and those that ought to be limited (energy, saturated fatty acids, sugar and salt). Each product is ranked on a 5-level scale, going from the most nutritionally valid product (A, dark green), to the least nutritionally favourable product (E, dark orange).

Examples:

Vegetable ravioli Product 1 is ranked **B** because it contains a sizeable quantity of vegetables and fibres, but also because it contains little of nutritional elements that ought to be limited as salt or saturated fatty acids.

Cheese ravioli Product 2 is ranked D because it contains more calories than product 1, more salt and saturated fatty acids, less vegetables and fibres.

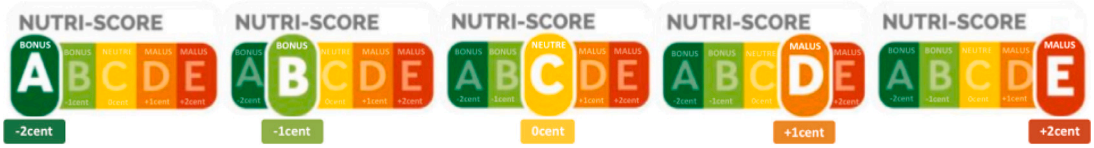
The Nutri-Score scale looks like this:

Price change according to this table:

[*Nutri-Score + small price*:]

Nutritionally worse			Nutritionally better	
Price decrease		No price change	Price increase	
−2 cent	−1 cent	0 cent	+1 cent	+2 cent

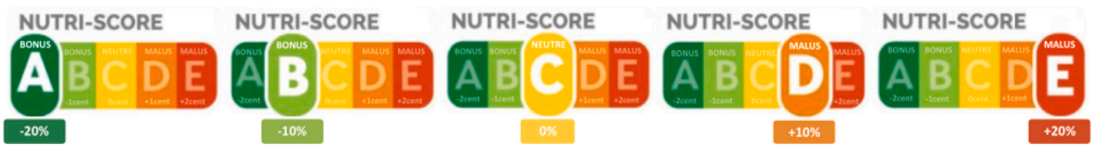
Changes are related to the Nutri-Score label:



[*Nutri-Score + small price*:]

Nutritionally worse			Nutritionally better	
Price decrease		No price change	Price increase	
−20%	−10%	no change	+10%	+20%

Changes are related to the Nutri-Score label:



Any questions?

[During the shopping task, the overhead projectors showed a reminder of the main features of the task. This is its text:] Reminder: you shop for the next 2 days for your household. You are free to choose the products and quantity you prefer; to spend the amount you prefer. You can retrieve the informations that you would find on the backs of packs, namely ingredients and nutritional information, on screen.

Ending

Phase 3: questionnaire and end of the experiment.

You will first be given two short questionnaires to fill in. Once the questionnaire filled, you will be asked to fill in the receipt for payment. Once everyone will be finished, an experimenter will call your code, and you will proceed to another room to purchase the food products of the randomly chosen basket.

Thank you for your participation.

Appendix C. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jebo.2024.106825.

Data availability

The data and code to fully reproduce the results contained in this article are available at the OSF page of the article here: https://osf.io/78x5f/.

References

Acton, R.B., Hammond, D., 2018. The impact of price and nutrition labelling on sugary drink purchases: Results from an experimental marketplace study. Appetite 121, 129–137. http://dx.doi.org/10.1016/j.appet.2017.11.089, URL https://www.sciencedirect.com/science/article/pii/S0195666317305925.

Acton, R.B., Hammond, D., Hammond, D., Hammond, D., Hammond, D., Hammond, D., 2020. Impact of sugar taxes and front-of-package nutrition labels on purchases of protein, calcium and fibre. Prev. Med. http://dx.doi.org/10.1016/j.ypmed.2020.106091.

Acton, R.B., Jones, A.C., Kirkpatrick, S.I., Roberto, C.A., Roberto, C.A., Hammond, D., 2019. Taxes and front-of-package labels improve the healthiness of beverage and snack purchases: a randomized experimental marketplace. Int. J. Behav. Nutrit. Phys. Act http://dx.doi.org/10.1186/s12966-019-0799-0.

Allcott, H., Lockwood, B.B., Taubinsky, D., 2019. Should we tax sugar-sweetened beverages? An overview of theory and evidence. J. Econ. Perspect. 33 (3), 202–227. http://dx.doi.org/10.1257/jep.33.3.202, URL https://www.aeaweb.org/articles?id=10.1257/jep.33.3.202.

Capacci, S., Allais, O., Bonnet, C., Mazzocchi, M., 2019. The impact of the french soda tax on prices and purchases. An ex post evaluation. PLOS ONE 14 (10), 1–22. http://dx.doi.org/10.1371/journal.pone.0223196, URL http://dx.doi.org/10.1371/journal.pone.0223196.

Carruba, M.O., Malavazos, A., Valerio, A., Nisoli, E., 2021. Front-of-pack (FOP) labelling systems, nutrition education, and obesity prevention: nutri-score and nutrinform battery need more research. Eat. Weight Disorders - Studies Anorexia, Bulimia and Obesity 27 (6), 2265–2266. http://dx.doi.org/10.1007/s40519-021-01342-x, URL http://dx.doi.org/10.1007/s40519-021-01342-x.

Cecchini, M., Warin, L., 2016. Impact of food labelling systems on food choices and eating behaviours: a systematic review and meta-analysis of randomized studies. Obesity Rev 17 (3), 201–210.

Charness, G., Gneezy, U., Halladay, B., 2016. Experimental methods: Pay one or pay all. J. Econ. Behav. Organ. 131, 141–150. http://dx.doi.org/10.1016/j.jebo.2016.08.010, URL http://dx.doi.org/10.1016/j.jebo.2016.08.010.

Chetty, R., 2015. Behavioral economics and public policy: A pragmatic perspective. Amer. Econ. Rev. 105, 1–33. http://dx.doi.org/10.1257/aer.p20151108, URL http://dx.doi.org/10.1257/aer.p20151108.

Chetty, R., Looney, A., Kroft, K., 2009. Salience and taxation: Theory and evidence. Amer. Econ. Rev. 99 (4), 1145–1177. http://dx.doi.org/10.1257/aer.99.4.1145, URL http://dx.doi.org/10.1257/aer.99.4.1145.

Crosetto, P., Lacroix, A., Muller, L., Ruffieux, B., 2019. Nutritional and economic impact of five alternative front-of-pack nutritional labels: experimental evidence. Europ. Rev Agricult Econ 47 (2), 785–818. http://dx.doi.org/10.1093/erae/jbz037, URL http://dx.doi.org/10.1093/erae/jbz037.

Dubois, P., Albuquerque, P., Allais, O., Bonnet, C., Bertail, P., Combris, P., Lahlou, S., Rigal, N., Ruffieux, B., Chandon, P., 2020. Effects of front-of-pack labels on the nutritional quality of supermarket food purchases: evidence from a large-scale randomized controlled trial. J. Acad. Market Sci 49 (1), 119–138. http://dx.doi.org/10.1007/s11747-020-00723-5, URL http://dx.doi.org/10.1007/s11747-020-00723-5.

Ducrot, P., Julia, C., Méjean, C., Kesse-Guyot, E., Touvier, M., Fezeu, L.K., Hercberg, S., Péneau, S., 2016. Impact of different front-of-pack nutrition labels on consumer purchasing intentions: a randomized controlled trial. Am. J. Prev. Med. 50 (5), 627–636.

Ducrot, P., Méjean, C., Julia, C., Kesse-Guyot, E., Touvier, M., Fezeu, L.K., Hercberg, S., Péneau, S., 2015. Objective understanding of front-of-package nutrition labels among nutritionally at-risk individuals. Nutrients 7 (8), 7106–7125.

Faccioli, M., Law, C., Caine, C.A., Berger, N., Yan, X., Weninger, F., Guell, C., Day, B., Smith, R.D., Bateman, I.J., 2022. Combined carbon and health taxes outperform single-purpose information or fiscal measures in designing sustainable food policies. Nature Food 3 (5), 331–340. http://dx.doi.org/10.1038/s43016-022-00482-2, URL http://dx.doi.org/10.1038/s43016-022-00482-2.

Fialon, M., Serafini, M., Galan, P., Kesse-Guyot, E., Touvier, M., Deschasaux-Tanguy, M., Sarda, B., Hercberg, S., Nabec, L., Julia, C., 2022. Nutri-score and NutrInform battery: Effects on performance and preference in Italian consumers. Nutrients 14 (17), 3511. http://dx.doi.org/10.3390/nu14173511, URL http://dx.doi.org/10.3390/nu14173511.

Gneezy, U., Rustichini, A., 2000. A fine is a price. The J. Legal Stud 29 (1), 1–17. http://dx.doi.org/10.1086/468061, URL http://dx.doi.org/10.1086/468061.

Grüne-Yanoff, T., 2018. Boosts vs. nudges from a welfarist perspective. Rev. d'économie Politique (2), 209–224.

Julia, C., Hercberg, S., 2017. Development of a new front-of-pack nutrition label in France: the five-colour nutri-score. PANORAMA 712.

Julia, C., Kesse-Guyot, E., Ducrot, P., Péneau, S., Touvier, M., Méjean, C., Hercberg, S., 2015. Performance of a five category front-of-pack labelling system – the 5-colour nutrition label – to differentiate nutritional quality of breakfast cereals in France. BMC Public Health 15 (1), 179. http://dx.doi.org/10.1186/s12889-015-1522-y, URL http://dx.doi.org/10.1186/s12889-015-1522-y.

Julia, C., Kesse-Guyot, E., Touvier, M., Méjean, C., Fezeu, L., Hercberg, S., 2014. Application of the british food standards agency nutrient profiling system in a French food composition database. Br. J. Nutr. 112 (10), 1699–1705. http://dx.doi.org/10.1017/S0007114514002761.

van der Molen, A.E., Hoenink, J.C., Mackenbach, J.D., Waterlander, W., Lakerveld, J., Beulens, J.W., 2021. Are nudging and pricing strategies on food purchasing behaviors equally effective for all? Secondary analyses from the supreme nudge virtual supermarket study. Appetite 167, 105655. http://dx.doi.org/10.1016/j.appet.2021.105655, URL http://dx.doi.org/10.1016/j.appet.2021.105655.

Muller, L., Lacroix, A., Lusk, J.L., Ruffieux, B., 2017. Distributional impacts of fat taxes and thin subsidies. Econ. J. 127 (604), 2066–2092. http://dx.doi.org/10.1111/ecoj.12357, URL http://dx.doi.org/10.1111/ecoj.12357.

Muller, L., Ruffieux, B., 2020. What makes a front-of-pack nutritional labelling system effective: The impact of key design components on food purchases. Nutrients 12 (9), http://dx.doi.org/10.3390/nu12092870, URL https://www.mdpi.com/2072-6643/12/9/2870.

Mytton, O.T., Clarke, D., Rayner, M., 2012. Taxing unhealthy food and drinks to improve health. BMJ 344 (may15 2), e2931. http://dx.doi.org/10.1136/bmj.e2931, URL http://dx.doi.org/10.1136/bmj.e2931.

Ng, S.W., Rivera, J.A., Popkin, B.M., Colchero, M.A., 2019. Did high sugar-sweetened beverage purchasers respond differently to the excise tax on sugar-sweetened beverages in Mexico? Public Health Nutrit 22 (4), 750–756. http://dx.doi.org/10.1017/S136898001800321X.

Nohlen, H., Bakogianni, I., Grammatikaki, E., Ciriolo, E., Pantazi, M., Dias, J.A., Salesse, F., Christofoletti, M.M., Wollgast, J., Bruns, H., Dessart, F., Marandola, G., Bavel, R.V., 2022. Front-of-pack nutrition labelling schemes: an update of the evidence. In: Technical Report KJ-NA-31-153-EN-N (online). Publications Office of the European Union, Luxembourg (Luxembourg), http://dx.doi.org/10.2760/932354(online).

Popkin, B., Schneider, P., Shekar, M., 2020. Addressing overweight/obesity: Lessons for future actions. In: Obesity: Health and Economic Consequences of an Impending Global Challenge. The World Bank, pp. 109–168. http://dx.doi.org/10.1596/978-1-4648-1491-4_ch5, URL http://dx.doi.org/10.1596/978-1-4648-1491-4_ch5.

Rayner, M., Scarborough, P., Lobstein, T., 2009. The UK Ofcom Nutrient Profiling Model: Defining 'healthy'and 'unhealthy'foods and drinks for TV advertising to children. OfCom, London.

Seiler, S., Tuchman, A., Yao, S., 2021. The impact of soda taxes: Pass-through, tax avoidance, and nutritional effects. J. Mar. Res. 58 (1), 22–49. http://dx.doi.org/10.1177/0022243720969401, URL http://dx.doi.org/10.1177/0022243720969401.

Silver, L.D., Ng, S.W., Ryan-Ibarra, S., Taillie, L.S., Induni, M., Miles, D.R., Poti, J.M., Popkin, B.M., 2017. Changes in prices, sales, consumer spending, and beverage consumption one year after a tax on sugar-sweetened beverages in Berkeley, California, US: A before-and-after study. PLOS Med 14 (4), 1–19. http://dx.doi.org/10.1371/journal.pmed.1002283, URL http://dx.doi.org/10.1371/journal.pmed.1002283.

Storcksdieck Genannt Bonsmann, S., Marandola, G., Ciriolo, E., Van Bavel, R., Wollgast, J., 2020. Front-of-pack Nutrition Labelling Schemes: A Comprehensive Review. Publications Office of the European Union, Luxembourg, http://dx.doi.org/10.2760/180167.

Szaszi, B., Higney, A., Charlton, A., Gelman, A., Ziano, I., Aczel, B., Goldstein, D.G., Yeager, D.S., Tipton, E., 2022. No reason to expect large and consistent effects of nudge interventions. Proc. Natl. Acad. Sci. 119 (31), e2200732119.

Touvier, M., Hercberg, S., Julia, C., 2021. Nutri-score vs NutrInform battery front-of-pack labelling systems: weight of scientific evidence matters. Eat. Weight Disorders - Studies Anorexia, Bulimia and Obesity 27 (6), 2267–2268. http://dx.doi.org/10.1007/s40519-021-01341-y, URL http://dx.doi.org/10.1007/s40519-021-01341-y.

Waterlander, W.E., Steenhuis, I.H., de Boer, M.R., Schuit, A.J., Seidell, J.C., 2013. Effects of different discount levels on healthy products coupled with a healthy choice label, special offer label or both: results from a web-based supermarket experiment. Int. J Behav Nutrit Phys Act 10 (1), 59.