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Economic assessment of nutritional recommendations: a comment*

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Abstract

This is a Comment on the paper by Irz et al. (2015) in this Journal, on nutritional recommendations. Irz et al. (2015) propose to compute the cost of a nutritional constraint as the consumer loss of surplus, derived from their observed choices. Introducing behavioral biases into an extended version of their model, I show that their proposed methodology implicitly assumes that consumer dietary choices do not involve any health considerations. The cost per Quality-Adjusted Life Year that they compute should be corrected by the size of the bias of consumers to be compared with benchmark evaluations.

Keywords: Nutrition; Biases; Public policy.

JEL Classification: DF1; D6; I1

1 introduction

Unhealthy diet, together with other behaviors (lack of physical activity, smoking, alcohol consumption), is a major health risk factor (e.g. Murray et al.; 2013, for the U.S.). Policies influencing people's diet are therefore likely to have major impacts on health. How to apply the standard economic tools of Cost-Benefit Analysis (CBA) and Cost-Effectiveness Analysis (CEA) to evaluate such policies is not straightforward. It requires to compute the cost for consumers of changing their diet, and compare it to the health benefits, and necessitates to take into account the likely bias (either informational or behavioral) of consumers.

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Irz et al. (2015) evaluate nutritional recommendations (e.g. share of fruits and vegetables, quantity of salt in the diet), by coupling an economic model with an epidemiological model. They model the consequences of a nutritional recommendation as a *constraint* on consumers choices, mobilizing the theory of optimal rationing (Jackson; 1991). Their contribution is notably to simulate the whole adjustment of consumers' diets following the implementation of such a constraint. They determine the 'taste cost' for consumers of several nutritional constraints and their health consequences (measured in Death Avoided). The cost is computed as the amount necessary to compensate the consumer for the constraint. Dividing the former by the latter they found a very low cost per DA, or Quality-Adjusted Life Year, and describe these recommendations as "highly cost-effective" (see also Irz et al.; 2016a,b).

The purpose of this comment is to qualify their conclusions by arguing that they implicitly assume that consumers do not take into account the health consequences of their diet choices. If consumers partially internalize these health consequences,¹ the benefits from the nutritional recommendations should be reduced by the amount internalized in a CBA or CEA. The analysis is left unchanged if the change of diet is triggered by an information campaign that modifies the subjective probabilities of adverse health consequences. The taste cost, computed by Irz et al. (2015), is then equal to the health benefits weighted by the change of subjective probabilities.

In section 2, I review part of the literature on the regulation of food and the correction of biases. In section 3, I introduce health and behavioral biases into the theoretical framework developed by Irz et al. (2015). In Section 4, an information campaign is considered. Section 5 introduces health care costs. Section 6 concludes.

2 Literature review

Nutrition policies are not straightforward to justify within the paradigm of revealed preferences, and their paternalistic flavor has generated both academic and public debate. In a welfarist setting, and in CBA, a policy that targets behaviors is justified if consumers make suboptimal choices from the regulator perspective. Concerning food and health, it could be argued that

¹Health is acknowledged as being one of the main food choice motives in survey based studies (Glanz et al.; 1998; Konttinen et al.; 2013), which is illustrated by the growing number of nutrition smart-phones applications.

consumers do not sufficiently take into account the impact of their diet on their health.

The discrepancy between the regulator’s valuation of a consumer’s health and the one revealed by her diet can be explained either by a disagreement on the value of her health, they do not have the same objective function; or an inconsistency between her choices and her own valuation of her health, her choices do not maximize her objective function. Let us review some theoretical arguments and empirical evidences of these two kinds of issues.

First, a welfarist regulator and a consumer can value the latter’s health differently, because of altruism or externalities. The consequences of altruism on CBA is theoretically investigated by Bergstrom (1982, 2006) and Jones-Lee (1991, 1992). The latter distinguishes pure altruism (Alice cares about Bob’s well-being) and paternalistic altruism (Alice cares about Bob’s *health*), and shows that only the latter should influence the valuation of health in cost benefit analysis. Empirical evidences suggests that people’s willingness to pay for others health and safety, notably their children’s, is non negligible (see Hurley and Mentzakis; 2013, for an illustration and references).

There are also direct externalities related to food and health. For instance, Griffith et al. (2017) analyze optimal alcohol taxation justified by externalities: public health care costs, violent behavior and drunk driving. Note that the last two are not related to the impact of a consumer’s choices on her health but on that of others’. They calibrate their external cost functions based on a study by UK Cabinet Office (2003) and found optimal VAT rates around 30%. MacEwan et al. (2014) measure the external cost of obesity in the form of publicly funded health-care expenditures for the United States. They found an average marginal cost of \$27 per year, per adult for a one-unit increase in Body Mass Index for each adult in the US population.

Second, behavioral and informational biases can explain that a consumer’s diet is not consistent with her own valuation of her health. Several articles have analyzed the optimal taxation of unhealthy goods (Gruber and Köszegi; 2001; O’Donoghue and Rabin; 2006a; Cremer et al.; 2012; Allcott et al.; 2014, 2018) when people imperfectly internalize the effect of these goods on their own health. There are many models of behavioral biases (e.g. multiple selves, hyperbolic discounting, inattention).² Concerning health and food, Gruber

²See Farhi and Gabaix (2017) for a review and a recent theoretical analysis of optimal taxation of ‘behavioral agents’ in a parsimonious and general model. They distinguish

and Köszegi (2004) justify cigarette taxation by self-control issues, modeled with hyperbolic discounting, which would explain that between 10% and 40% of the health consequences of smoking are neglected by smokers.³

Maybe the simplest explanation for an inconsistency between one's choices and one's valuation of health is that people have imperfect information about the relationship between their diet and their health. Similar situations have been theoretically investigated notably by Hammond (1981), Johansson-Stenman (2008) and Salanié and Treich (2009) for the provision of public safety.⁴ Réquillart et al. (2016) survey evidence that consumers differ regarding their knowledge of the health consequences of salt intake and their own salt consumption (e.g. Kenten et al.; 2013; Grimes et al.; 2009; Newson et al.; 2013).

In their analysis of optimal soda taxation, Allcott et al. (2018) estimate both a behavioral and an informational bias. They implement a survey to measure households' self-control and nutrition knowledge, and then determine a counter-factual optimal consumption that would be chosen if people had the nutrition knowledge of nutritionists and perfect self-control.⁵ They found that the average American household would consume approximately 38% fewer sodas if they had the nutrition knowledge of dietitians and nutritionists and no self-control problems, and an average money-metric bias of 1.14 cents per ounce. They also consider an external cost associated to health care costs of 0.85 cents per ounce, an individual supporting 85% of a total health care cost of 1 cent per ounce (from Wang et al.; 2012).

two broad categories of biases: misperception of prices and internalities (people do not maximize the 'right' utility function).

³Angeletos et al. (2001) provide an overview of empirical evidence and estimates of the hyperbolic discounting parameters.

⁴Salanié and Treich (2009) distinguish between a paternalistic regulator that evaluates the situation with his own estimate of the risk, and a populist regulator that uses the regulated agents'. This distinction is similar to the one introduced by Hammond (1981) between ex-post and ex-ante efficiency. Note that 'paternalism' has not the same meaning as in Jones-Lee (1991, 1992) who considers the paternalistic concern of one consumer for another consumer's health.

⁵They attribute the methodology to Bronnenberg et al. (2015) and Handel and Kolstad (2015), a key implicit assumption is that preferences are conditionally uncorrelated with measures of biases.

3 Correcting biases

To make my point, I use the same standard conceptual framework as Irz et al. (2015) but I disentangle taste and health in the utility function of the consumer which is then $U(T(x), Q(x))$ instead of $U(x)$. The budget constraint of the consumer is $p \cdot x \leq M$ and the nutritional recommendation constraint $a \cdot x = R$; a , p and x are vectors of dimension H ; M and R positive real numbers. $Q(x)$ is the health in QALYs as a function of the diet, and $T(x)$ its taste. To simplify, separability is assumed: $U(T, Q, \theta) = T(x) + \theta v Q(x)$, in which v is the value (in utils) per QALY. The parameter θ is used to represent the consumer's bias: the true utility generated by the consumer's choice is $U(T, Q, 1)$ but she chooses according to $U(T, Q, \theta^B)$ with $\theta^B \in [0, 1]$.⁶ The function $U(T, Q, \theta^B)$ corresponds to $U(x)$ in Irz et al. (2015) in the sense that it is revealed by the observed consumer's choices.

The behavior of the consumer without the nutritional constraint is observed. She chooses $x(p, M, \theta^B)$ that, in theory, maximizes $U(T, Q, \theta^B)$ subject to the budget constraint and solves the H equations (derivatives are denoted with subscripts, T_x and Q_x are the gradients of T and Q):

$$T_x(x) + v\theta^B Q_x(x) = \lambda p$$

in which $\lambda(p, M, \theta^B)$ is the Lagrange multiplier of the budget constraint.

Irz et al. (2015) introduce the nutritional constraint R as follow: the vector $x(p, M, \theta^B, R)$ maximizes $U(x, Q, \theta^B)$ subject to $p \cdot x \leq M$ and $x \cdot a \leq R$, these quantities satisfy

$$T_x(x) + v\theta^B Q_x = \lambda p + \mu a \tag{1}$$

In which μ is the Lagrange multiplier of the dietary constraint, and μ/λ its dollar value as revealed by the choices observed.

Let me define the indirect utility function:

$$V(p, M, R, \theta^B, \theta) =_{def} T(x(p, M, R, \theta^B)) + v\theta Q(x(p, M, R, \theta^B)) \tag{2}$$

⁶ As highlighted in the literature survey, there are two issues: The consumer and the regulator might value the health of the former differently. And the consumer might imperfectly internalize the effect of x on Q when choosing x even though she agrees with the regulator on the value of her health. In case of altruism, the difference $(1 - \theta)v$ is the value of the consumer's health for others.

it is the utility evaluated with the parameter θ with quantities chosen according to θ^B . The regulator uses $V(p, M, R, \theta^B, 1)$ to evaluate the situation, which can be rewritten:

$$V(p, M, R, \theta^B, 1) = V(p, M, R, \theta^B, \theta) + v(1 - \theta)Q(x(p, M, R, \theta^B)) \quad (3)$$

The regulator wishes to compare the cost and benefit of a small tightening of the constraint R : R is reduced by $dR \leq 0$ from its unconstrained level. Quantities change by $dx = x_R dR$, and health by $dQ = Q_x dx$.

Irz et al. (2015) define the ‘taste cost’ as the cost revealed by consumer choices. This revealed cost, to be denoted $C(R)$, is defined as the compensated variation:

$$V(p, M + C(R), R, \theta^B, \theta^B) = V(p, M, R^0, \theta^B, \theta^B) \quad (4)$$

and for a tightening of the constraint, $dR \leq 0$, the cost changes by:

$$dC = C'(R)dR = \frac{-V_R(p, M, R, \theta^B, \theta^B)dR}{V_M(p, M, R, \theta^B, \theta^B)} = -\frac{\mu}{\lambda}dR (\geq 0)$$

Making use of this relationship, and Hicksian demands, Irz et al. (2015) compute dC .

3.1 Cost benefit analysis

From the regulator’s point of view the tightening is worth implementing (ignoring the cost of implementation) if

$$0 \leq (T_x + vQ_x)dx = v(1 - \theta^B)dQ + \mu dR \quad (5)$$

$$\Leftrightarrow v(1 - \theta^B)dQ \geq -\mu dR (\geq 0) \quad (6)$$

$$\Leftrightarrow \frac{v}{\lambda}(1 - \theta^B)dQ \geq dC \quad (7)$$

Note that $v\theta^B/\lambda$ is the value of a QALY that would be inferred by observing the choices of the consumer. Assuming that v/λ is approximately the value of a QALY, the formula differs by a factor $(1 - \theta^B)$ from the implicit valuation from Irz et al. (2015).

Note also that starting from an unbinding constraint the cost is indeed small since μ is close to zero.⁷ It is therefore normal that Irz et al. (2015) find small ‘taste costs’.

⁷Similarly the welfare cost of imposing a very small tax is negligible, a fact that has been exploited by O’Donoghue and Rabin (2006b) to justify sin goods taxation.

It is worth stressing that the taste cost is revealed by (and calculated from) the consumer’s behavior. The choice of θ^B does not change the revealed utility function, and the computed taste cost, but it changes the value that is left un-internalized $v(1 - \theta^B)$ per QALY. Alternatively said, the willingness to pay for a tightening of the constraint, measured by the cost dC , already encompasses an health benefit of $v\theta^B dQ$ that should not be counted twice.

A simple example might help: the regulator envisions preventing a consumer from eating an additional pizza, a sacrifice that would increase her life expectancy by 1 second. From observing her behavior, we determine that she is willing to pay $dC = 8\$$ for that pizza, and we know she is willing to pay 10\$ for any additional second of life expectancy. Comparing dC with 10\$ suggests it is worth preventing her from eating the pizza: she would willingly sacrifice the pizza for an additional second of life expectancy. However, if, when choosing the pizza, she anticipates a loss of 0.6 seconds of life expectancy, worth 6\$ ($\theta^B = 6/10$), and compares it with a gustatory pleasure worth 14\$, she still has to be paid $dC = 8\$$ for not eating the pizza, but there are only 0.4 additional seconds, worth 4\$ to be compared with the cost dC .

3.2 Cost effectiveness analysis

To avoid determining the value of a QALY one can resort to CEA and rank health policies according to their cost per QALY. The issue is then to determine the relevant cost of the dietary recommendation. Let us consider a benchmark policy costing $c\$$ per QALY, unrelated to the consumer’s diet (e.g. road safety).⁸ The welfare generated per dollar is

$$v - V_M c = v - [\lambda + v(1 - \theta^B)Q_{x \cdot x_M}]c \quad (8)$$

the bracketed term represents the value of a dollar from the regulator’s perspective. The second term within that bracket is the utility gains from the health consequences of being richer.⁹ Because of the bias, the value in utils of an additional dollar is larger, if $Q_{x \cdot x_M} > 0$, than the value revealed by the consumer’s choices (λ).

⁸Irz et al. (2015) mention the National Institute of Health and Care Excellence in the UK that considers a ceiling value of £20-30k per QALY.

⁹Indeed, that wealthier people have a healthier diet does not imply that an additional dollar systematically improves a consumer’s diet.

The above benefit should be compared with the dietary recommendation that generates:

$$v(1 - \theta^B)dQ - \lambda dC \quad (9)$$

To compare the two, one can either compare the costs to reach a given health social benefit, or compare the benefits for a given cost.

First, comparing the costs to reach a benefit v indicates that the dietary recommendation outperforms the benchmark intervention if and only if (dividing eq. (9) by $(1 - \theta^B)dQ$):

$$\frac{dC}{(1 - \theta^B)dQ} \leq c \times \left[1 + \frac{v}{\lambda}(1 - \theta^B)Q_{x..x_M}\right] \quad (10)$$

Second, comparing the benefits per dollar (dividing eq. (8) by c and eq. (9) by dC), the dietary recommendation yield a larger benefit per dollar if and only if

$$\frac{(1 - \theta^B)dQ}{dC} \geq \frac{1}{c} - (1 - \theta^B)Q_{x..x_M}$$

or, equivalently,

$$\begin{aligned} \frac{dC}{(1 - \theta^B)dQ} &\leq c \times [1 - c(1 - \theta^B)Q_{x..x_M}]^{-1} \\ &\simeq c \times [1 + c(1 - \theta^B)Q_{x..x_M}] \end{aligned} \quad (11)$$

The advantage of eq. (11) over eq. (10) is that v does not appear.¹⁰ The two comparisons are equivalent if either $x_M = 0$ or $\theta^B = 1$ and involve the cost per QALY $dC/(1 - \theta^B)dQ$.

If $x_M \neq 0$, the two comparisons are equivalent for $\theta^B = 1$ thanks to the consistency of the welfarist revealed preference approach, but under the arguable assumption that consumer dietary choices are fully consistent with their objective health consequences. In such a case the dietary recommendation should not be implemented. And, if $Q_{x..x_M} > 0$ and $\theta^B < 1$, the benchmark policy cost should be inflated by the health consequences of an additional dollar. From the regulator perspective, with biased consumers, an additional dollar is worth more than as revealed by consumers choices, if it makes people healthier. For $\theta^B = 0$, the dietary recommendation is even more appealing than suggested by Irz et al. (2015).

¹⁰The comparison of costs (11) can also be obtained by considering that if the benchmark activity is socially desirable then $v \geq \lambda c[1 - c(1 - \theta^B)Q_{x..x_M}]^{-1}$ and injecting this inequality into eq. (9) gives the sufficient condition: The health recommendation is socially desirable if eq. (11) is satisfied.

4 Information Campaign

The previous discussion concerns the evaluation of a dietary *constraint* enforced with optimal rationing. However, the underlying reasoning behind the analysis of Irz et al. (2015), is that the change of diet would be triggered by an information campaign. They articulate this reasoning in another article (Irz et al.; 2016a, p.142):

Instead, we consider that information affects behaviours through changes in the subjective probabilities of adverse health outcomes linked to consumption patterns. Thus, as a result of a recommendation and its promotion, the consumer modifies his arbitrage between short-term rewards from food consumption and long-term reward from improved health. In the short term, this adjustment has a welfare cost, which we measure and identify as ‘taste cost’.

Here, I have defined T as the short-term ‘hedonic’ rewards, and $U(T, Q, \theta^B)$ as the revealed utility function which corresponds to the function $U(\cdot)$ in Irz et al. (2015, 2016b). An information campaign would modify choices via a change of θ^B , interpreted as a subjective probability of adverse health outcomes, and it would be *as if* a dietary constraint was enforced.

Let us denote θ_0^B the initial subjective probability and $\theta^B(R)$ the one that enforces the nutritional constraint R :

$$x(p, M, R, \theta_0^B) = x(p, M, +\infty, \theta^B(R)) \quad (12)$$

this expression indicates that the diet with the constraint R but no information (the left hand side) is equal to the diet without the constraint but an information campaign (the right hand side). Looking at the first order conditions (1) satisfied by these two diets, they are equal if and only if

$$v \times (\theta^B(R) - \theta_0^B) Q_x = \mu a \quad (13)$$

in which μ is the Lagrange multiplier of the dietary constraint for $\theta^B = \theta_0^B$.¹¹

The regulator’s objective function, $T(x) + vQ(x)$, does not depend on the precise mechanism through which the diet is modified, whether it is via information or rationing. It could be written in two different ways that either

¹¹Indeed, that θ^B is the same for all x is problematic here. A better approach would be to have θ^B a H-dimensional vector with one bias per good, or alternatively define Q as a function of some key quantities: calories and nutrients related to the nutritional recommendation ($(Q(R_1, \dots, R_n))$ with $R_i = a^i \cdot x$) and a bias for each of these. A nutrition recommendation would modify differently the elements of θ^B .

highlight the role of the information campaign or exhibit the observed prior preferences:

$$T(x) + vQ(x) = \underbrace{[T(x) + v\theta^B(R)Q(x)]}_{\text{maximized by } x} + v(1 - \theta^B(R))Q(x) \quad (14)$$

$$= \underbrace{[T(x) + v\theta_0^B Q(x)]}_{U(x) \text{ in Irz et al. (2015)}} + v(1 - \theta_0^B)Q(x) \quad (15)$$

And an evaluation of a campaign that leads to a tightening of the constraint $dR \neq 0$ is, taking the derivatives of eq (14) and (15) :

$$d[T(x) + vQ(x)] = v(1 - \theta^B(R))dQ \quad (16)$$

$$= v(1 - \theta_0^B)dQ - dC \quad (17)$$

The first line could be interpreted by an envelope argument from equation (14), only the external benefit associated to the change of health matters, and, surprisingly, the taste cost does not appear. The second line solves this apparent paradox, and reconciles the first line with the analyzes of Irz et al. (2015) and the previous section. The taste cost, implicitly computed with the prior belief, should be compared with the health benefits computed also with the prior belief.

5 External cost

A possible justification for nutritional policies is the external cost of an unhealthy diet via a public health system. The framework can be extended to account for health care costs. Let us assume that these costs are $h(1 - Q(x))$ in which h is in \$/QALY. If these costs are paid from a public budget, the after tax revenue of the consumer is $M - h(1 - Q(x))$. When choosing her diet, the consumer ignores the consequences of her choices on these costs, and her diet is still described by the H equations (1).

From the regulatory perspective the diet recommendation is worth implementing if and only if

$$[v(1 - \theta^B) + V_M(\theta^B, \theta)h]\Delta Q - \mu \geq 0$$

in addition to a better health, the consumer also benefits from the reduction of the health care costs, a benefit that does not involve the bias of the consumer. A benchmark policy that costs c per QALY yields: $v + V_M[h - c]$, with $V_M(\theta^B, 1) = \lambda + v(1 - \theta^B)Q_{x.x_M}$. If this benchmark is worth implementing, then

$$v \geq \lambda \frac{c - h}{1 - (1 - \theta^B)Q_{x.x_M}(c - h)}$$

and the dietary recommendation is worth implementing if

$$\frac{dC}{dQ} \leq \frac{(c - h)(1 - \theta^B) + h}{1 - (c - h)(1 - \theta^B)Q_{x.x_M}}$$

This comparison is a generalization of eq. (11) with an external cost h . Even if $\theta^B = 1$, the external cost h remains and should be compared with the cost per QALY $C'/\Delta Q$. It is a standard externality situation. The difference $c - h$ is related to the value of a QALY for an individual, and indeed the more biased the consumer, the lower θ^B the more appealing is the dietary recommendation.

6 Conclusion

Nutrition recommendations, together with other policy targeting behaviors (smoking, physical activity, alcohol consumption), are likely to have large positive impacts on health. Irz et al. (2015) propose a methodology to evaluate nutritional recommendation by computing their costs as the loss of surplus for consumers, derived from their observed choices. I clarified that they implicitly assume that these choices embed no health considerations, an extreme position. Assuming a behaviorally biased consumer I analyzed how to correct their evaluation.

Indeed, in a welfarist, revealed preference, framework there cannot be any benefit to constrain a perfectly informed and rational consumer, except if there is an externality or paternalistic altruism. To reconcile this fundamental result with the analysis of nutritional recommendation proposed by Irz et al. (2015) one has to introduce behavioral or informational biases. Only such biases can explain that people would be willing to pay for being constrained, and change their behavior when being told to eat 5 fruits and vegetables per day. Doing so highlights that health benefits should be reduced by the amount already internalized by consumers.

The integration of consumers biases into cost-benefit and cost-effectiveness analysis is necessary to evaluate policies targeting behaviors in a welfarist setting. But the estimation of such biases is difficult, Allcott et al. (2018) proposed a recent methodology. I subsumed these biases into only one parameter. It seems very likely that these biases vary depending on the good, or the ingredient, some risks being under-valued (e.g. cancer from alcohol) and some other over-valued (e.g. cancer from pesticides). Such an approach would be more consistent with the diet approach at the heart of the Irz et al. (2015) contribution.

The analysis of an information campaign assumed that it operates via an updating of subjective probabilities by consumers. However, it is likely that these campaigns work through multiple psychological channels (Jacquier et al.; 2012). Whether their evaluation should take into account precisely how they influence consumers behavior is a question for future research.

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