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# Nutrition Sensitive Consumption as a Way to Achieve a Healthy Diet: Working with Dissonance as Revaluation of Foods and Respecting Nutritional Norms

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## ABSTRACT

This paper deals with a new methodological approach allowing us to bring nutrition sensitive consumption closer to consumers' attention. We establish a theoretical model in which individual choices (subjective utility) shall correspond better with choices at societal level (objective norms). A first hypothesis is that individual households, in their decisions on what foods to buy, additionally may depend on norms; not only taste. But this creates dissonance. A second hypothesis is: dissonance is minimized. This results in a modification of perceptions and valuation (preference ordering) on possible diets. The idea is to show how norms can modify individual households' choices.

***Keyword**: nutrition values; decision making; nutrient sensitive consumption; cognitive dissonance*

## 1 Introduction

In this paper we discuss a new method on how one can explain and model the interaction of nutrition norms and preferences by using the concept of dissonance. Dissonance is measured along a concept of struggling to buy nutritious foods. The concept can be also understood as a way to sensitize decision making in households on needs for a healthy diet (needs with respect to an "objective" norm on energy, vitamins, micro-nutrients, etc.). The analysis is embedded in the debate on rationality of consumer decisions (i.e. obesity vs. health, sugar vs. vitamins, etc.). It will come up with an "assessment" (weights) for nutrients which can become as "objective" similar to "prices". (We use actually weights and scoring, synonym). The major question tackled is: can households which, for example, buy food from markets, "rationally" adjust preferences for finding a compromise between aspects which "ought to be consumed" and "liked" (see Elster, 1983 on sour grapes)? A final valuation shall be based technically on minimal cognitive dissonance, and we explain a possible methodological procedure. Hereby we address health issues in consumption. In that regards what is our starting? We suppose: currently (though it lacks theoretical background in terms of bounded rationality) decision making usually assumes purely methodological individualism and utility (as preferences also for food). Preferences state the background (Varian, 2014). Utility is a subjective, generic aim and revealed preferences are the foundation in microeconomic theory of choice (Varian, 2014). Instead we will show how attainment of a more healthy diet can be firstly worked out along "objective" valuation of diets which are based on nutrient needs and energy stated. Secondly, we combine needs with individual preferences (utility) using a concept of dissonance.
The objective of the paper is to show how norms for dietary intake can be linked to preferences, as needs come first and then preferences form along a combination of refereeing to dissonance, i.e. if rankings by preference and need are contrasted. So we get a hybrid. Norm setting, as investigated in the paper, is driven by effort (energy) minimization and it simulates achieving an acceptable nutrition level; though it must be flexible, also to integrate taste. Then the tertiary question is: how one can influence behaviour of households in favour of more nutritious diets? The environment and context, in which the topic will be studied, is a consumption system which has an emphasis on low diverse diets and households spend few in terms of time (effort) to improve diet. Yet, we do not endeavour in the usual "education, nudging, enlightenment, counselling, etc."



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literature; rather the aim is to model a norm setting which provides a balance between individual utility and collective nutrition rationality.
The norm setting as investigated in this paper is driven by effort minimization and achieving an acceptable nutrition level which serves as reference and norm formation. However, norms are usually not fully pursued. Hence, norm setting is later understood as compromise between preferences (subjective) and nutrition needs (objective as needs). For a reference to theories of norm building we refer to philosophical, social and psychology aspects (Bicchieri and Muldoon, 2011). Here, it is presumed that such norms exist. Apparently, there might be many social processes which are highly acknowledging norm setting; however, for a model based analysis, which is statistically inferable, simplifications are needed. Since we don't go too deep into the complex process of how norm are anticipated, we will only analyse some simple steps of getting a balance. (Exactly we want to investigate a method, which helps us to comprehend how nutrition norms can come into decision making based on modifying coefficients in behaviour analysis as model). The type of analysis proposed is an expansion of economic thinking of optimization to the complex issue of finding a compromise. By doing so, we suggest a layered optimization, first at norm and utility level, and then we combine weights and add dissonance.

## 2 Conceptual framework

We will follow a sequence which is starting with a lesser "economic" oriented approach and seeking to ground nutrition in a "nutrition science" approach. This approach, however, still follows an economic type of optimization. In the approach energy spending for nutrition is the objective and nutrition is a constraint. This facilitates minimization of negative health for consumers and we will link this type of treatment of nutrition to utility maximization by introducing weights. The idea, as outlined, is that, since we do not have an ultimate measure for nutrition sensitive consumption in terms of value, we can use weights to nutrition (scores) for compare it with "well-being" (willingness to spend money for preference). In this regard nutrition is indirectly measured as revealed inclination to work for a better diet (favouring certain scores of nutrition). Apparently this is a primal solution. The dual is maximizing nutrition given energy spent on food. Then the norm becomes flexible. Note, norm setting and statistical evaluation are not looking at preferences; rather a norm is coming from nutrition scientist. Moreover, since we will look at marginal changes, building or ordering crops is a way of making nutrition (optimization) flexible; and it will be show that this is sufficient for streamlining dissonance between nutrition driven by needs and utility driven by preferences.
The conceptual framework which underlies the presented approach can be described as contingent decision making of consumers who are dependent on norms as well as behaviour is depending on preference; both give scores (weights) simultaneously. The underlying thoughts have to be understood as follows: individual households make decisions on efforts for getting nutritious diets; and it is assumed that diets are normative as they are firstly dependent on information of "healthy" foods (healthy diets). "Healthy" foods shall ideally serve the human body with nutrients in need and they can be represented by a certain diet. The norm will be found at "public" level; i.e. it is given by nutrition science or experts. Then individual and social levels are to be brought into balance (equilibrium). An important aspect is that a society can establish the norm and balance as well as it determines conditions for interaction. Secondly, for qualifying the initial (starting) condition as nutrition optimization, we take (as reference) a pure specification of a diet from a nutrition point of view. I.e. taste (preference) does not matter first in the formulation of the model; in other words an artificially designed nutrition constraint is exogenous. Actually the modelling depends on this information given by experts.
For the setting of the quantitative relationship between a scoring of food crops and the optimal procurement, a measurement of nutrition achievements is firstly given as exogenous parameters. The reflection on what is healthy is that of a nutrition expert and it is used as constraint in an optimization. We suggest that efforts shall be minimized in a primal problem. In effect the primal is designed as an ill-posed problem similar to linear programming expanding into non-linear programming (Paris and Howitt, 1999). For instance a behavioural description and valuation of nutrition are possible as in quadratic outlay which shows flexibility and response to different scoring of foods (below). The behavioural depiction secondly refers to a revealed preference approach, now on expert opinion and minimal effort. After conducting an analysis of food (crop) use in households for nutrient needs, the exposition is done as ill-posed problem (Paris and Howitt, 2000); it enables us to retrieve a behavioural function. Hereby an initial constant constraint (norm) acquires the feature of a demand (function). As in a usual optimization, the constraint receives a shadow price vector (but now for a certain nutrition level). The vector is similar to a weighting. Indeed as in dual programming, nutrition can become a goal. From that point of view the model is grounded in behavioural theory and has empirical substantiation; i.e. the inverse of the primal dual model is investigated. In the dual model efforts in energy equivalents are constraints and nutrition values (scores) are the goal. These scores are then compared to the usual utility and preference values which are obtained in a similarly specified diet; but there diet is preference given!



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In this analysis any assignment of values (as scores or weights) is by optimization, and it is goal oriented. Having values found, given a numerical consignment for instance, maximum entropy (Golan et al. 1996,) allows us to get coefficients for a behaviour function. The purpose is to get a straight representative of revealed "goals" for both nutrition and utility. The just sketched approach works like a laboratory device looking at response, variation and valuation of diets, simultaneously driven by internal scoring. For illustration; from cross-section analysis and modelling average attainments in nutrition, values (scores) can be gathered. In a second step values expressed in units of account, energy used and utility are translated into scores. On average energy use can be orientation (numeraire) for both, (1) to look at improvements from policy side and (2) to take care of nutrition. A repeated step is also to qualify an objective function of utility maximization. Then the two scores are combined. The combination works as giving scores by dissonance and then, in a final step, dissonance is minimized.

## 3 Programming as method to get flexible nutrition

In this section we start demonstrating how programming can help us in achieving a flexible nutrition optimization based on a norm. This optimization will give shadow prices (scores) for nutrient and later shadow prices shall become adjustable. As in a usual programming problem, we take a linear objective and it is constituted as if having a constrained system in matrix expression (Paris and Howitt, 2001). Such approach can be applied to finding least efforts "e" for a diet "d" (nutrition norm) given "technology A". I.e. to get a certain nutrition level where "d" being an optimal diet, efforts are necessary; for example, in a traditional way of producing the contributions of resource and yields matter (production function approach). Here, we look at crops contributing to vitamins, micro-nutrients, etc. and i.e. as if we look at subsistence.

$$\begin{aligned} &Min \quad \varsigma \cdot [e] \\ &s.t. \qquad A[e] \geq d \end{aligned} \tag{1}$$

In our case ς is a measure of per-unit-effort; i.e. for effort e which is applied per crop, a unit ς counts multiplied by e: ς·e. It is related to production of a certain crop. Then $A_c$ translates into food and food translates into nutrients $A_d$. For diet d a stepwise $A_c \cdot A_d = A$ must be realized by working for crops, i.e. traditionally a production unit and household convert crops into diet. The diet is composed of different things like calories, protein, micro-nutrients, etc. From programming there is a primal optimum e* which gives optimal efforts to be applied. For the moment we are not distinguishing for different labour needs, farms or households, etc. and A might be complex. The corresponding dual is an optimization of shadow prices given energy.

$$\begin{aligned} &Max \quad d \cdot [\upsilon] \\ &s.t. \quad A^{-1}[\upsilon] \leq \varsigma \end{aligned} \tag{2}$$

From primal and dual optimization we get optimal e* and υ* respectively. A next step is to get a flexible way of describing the optimality and offering possibilities to change behaviour, here as being modified by joint scores. In fact, programming offers a data set for positive analysis (Golan et al. 1996) being a tool to solve an ill-posed observation problem (Howitt and Paris, 1998). It can be carried out with altered diets; but structure remains the same. Additionally we can introduce further dependencies, for example on household size, composition of energy needs, etc.

However, in principle, maximum entropy offers flexible functional forms which in our case are grounded in energy use per unit of nutrition in a diet; and from dual shadow prices we get information on weighting nutrients (scores see below). They become related to nutrition objective (3). This is a statistically created objective which is similar to a behavioural instance.

$$O^n = .5[d]' Q_{11}^n [d] + [\varsigma]' Q_{12}^n [\varsigma] + .5[\varsigma]' Q_{13}^n [\varsigma] - \varsigma' [e] + [\nu]' [d]_1 \tag{3}$$

From the formulation (5) we get optimal efforts and shadow prices. A differentiation gives:

$$\partial O / \partial [\varsigma] = Q_{12}^n [d] - Q_{13}^n [\varsigma] + [e] = 0 \tag{4a}$$

$$\partial O / \partial [d\ ] = Q_{11}^n [\varsigma] + Q_{12}^n [e] = \upsilon \tag{4b}$$

As interpretation, from summing up the product ς·e, we get the total effort which in a dual situation can be a constraint to the achievement (optimization of nutrition values). A (superior) diet is possible if more energy is used (vice versa). I.e., if in the end an inferior situation of not achieving an optimal diet is assumed, diets can



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get better. Programming can be applied for detection of nutrition deficits; and υ 's are values that are weights for priority (scores) if we look at nutrients and efforts under constraint condition, 'd=A·e'. Since we want to investigate deficits in food composition, energy spending might be one constraint and, in fact, it is possible to impose further constraints making the analysis richer in terms of issues and valuing. Yet, energy has the advantage that it can become a numeraire (like income). The behavioural equations (4a and b) correspond to determination of shadow prices υ. These are measured in terms of energy equivalents as dependent on per unit energy requirement. Note the diet has been presumed to be a fix unit on the one hand. Then cost minimization reveals the objective function behind, being stated by the behavioural (programming) data; i.e. at the other hand more we aim at recovering coefficients, more the norms become flexible. Though being flexible the norm is a revelation of expert opinions. In that respect it is "objective" and the norm creates values. The aim is to compare options with respect to cost minimization of diets taking values υ as weights (scores, if we add the weights to 100 p.c.); though they represent the ideal diet. The limitation is that the suggested diet is not part of a general optimization which is straight including preferences and norms. But a compromise can be found doing similar with a preferred (subjective) diet. In that case income serves as constraint and also scores appear.
From a theoretical angle, the above presented dietary specification of food use can be considered a "demand" function with a specific diet as a choice which is seemingly fix as outcome initially, but can be contingent on shadow prices (weighting of importance). I.e. we refer to the argument of revelation also in case of diet such as: shadow prices become weights and weights are similar to scores. Again, if we look at revealed behaviour to get an outcome, now it is a normative demand for healthy diet; thought the optimal norm is flexible and apparently behaviour is both, norm and demand driven. It implies our norms are flexible which again mean, they can equate with other things like preference (below). In any case the diet is "observed as reference" (recommended); and seeing it a "demand", diets becomes flexible within a frame as they depend on values associated with suggested norms. Any behaviour depends on "shadow prices"; and there is a need to find joint shadow prices in equilibrium with other shadow prices. For now, a shadow price is in energy equivalents (minimization) and we can use utility maximization in energy equivalent as maxim if labour is the unit of account (below). The equilibrium can be reckoned by a new optimal ratio between costs and benefit for a household. I.e. marginal benefit and costs equate and the inverse (value integration) delivers a fletched objective. In that regard a diet is flexible as "nutrition norm" demand.

## 4 Excursion on diet, energy use and income subject to gradual change from sustenance

In the objective, introduced so far, the nutrition achievement was given by an ideal diet based on energy consumption like in subsistence. Modifying the objective in case of market exchange is necessary because with the purchase of some food items the energy needed would decrease drastically; simultaneously income is exchanged for energy. But energy and income correspond. For nutrition (norm) aspects which are given by a request to supplement preference modelling (see below), our modelling should have more the character of balancing of energy than full subsistence. Yet, we have to look at income and energy. In that regards there is no "free lunch" for nutrition aspects of income minimization, because a relationship between utility and income on one side and nutrition to energy spent, emerges on the other side. Nutrition centres on health while it is competing with taste, convenience, etc. and this is hard to be established. Therefore modelled individual preferences (segment below) it must be linked to the scoring of nutrition values. Speaking as an economist there seems to be a trade-off in rationality (more health vs. taste). Yet, the aim is to model this trade-off. At this point, the disadvantage is that the preferred diet can spoil the nutrition objective because purchased (industrial) foods are considered less nutritious than original, self-produced, etc. Additionally there may be the delusion that energy use is less. The household maybe purchases too much of "wrong" things. We could treat that in pure nutrition/energy versions. Then a deviation can be modelled in which nutrient content is lower than in reference cases. A complicated way (9) would be that "more taste" is purchased from markets as compared to own produced crops.

$$[c_m] = [c^r] - N_{11}[[q_s^r]_m - [q_s]_m + [q_m]_m] \quad (5)$$

In this equation crops c are purchased from market m using an energy oriented exchange of commodities sold $q_s$ and bought $q_m$, yet on the basis of reference r from subsistence. The option is production of cash crops in an agrarian model to get income and income can be traced back to energy spent on crops to get income. The remaining decision issue is then a new valuation under market condition for nutrition and exchange; instead of selling goods for income efforts count; for instance, in such way as looking for subsistence crops, crops are purchased but purchase means that other energy consuming goods are sold. In intermediary semi-commercial systems, crops bought from the market are indirectly involved as they request labour (labour can be used in farm production for exchange or industrial occupation).



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## 5 Utility and market procurement with income generated by labour

However, in this paper the whole transition "from effort to income" cannot be described. Yet, we merely look at a household in terms of expenditure minimization and glimpse there is a coupling of effort and income. The specific scope is deriving a similar (marginal) value function of income compared to effort. This function then shall be balanced as preference function with nutrition. For the moment it implies a meta-construction, here of a well-being function, based on conflict between nutrition (health) and utility (taste); further note that there are several methods to get a balance (below). Our version is to link shadow prices as dissonance.

In that respect we need to get a similar system of value for purchased food compared to effort (above); it should be the basis to get a monetary value (below). In a revised version for utility maximization prices are given and energy for home-production of foods is internal (using a Lancaster approach, see Muellbauer, 1974, but now in programming). I.e. it means that we use food prices and also energy and insert the new conditionality in constraints. Then expenditure can be minimized along labour costs (income); hereby the purchase of food crops is controlled in an "economic" compartment of markets. Again, we receive a conditional "demand"; but now driven by utility. The utility is derived from an observed diet (no ideal one: it replicates taste preferred diets) which represents a typical consumer, who seeks taste. The idea is again programming of revealed preference and finding a generalized form. The major issue for embedding food choice in preference driven modelling is that an exchange is created. To exemplify: labour is used in production for income and then income is spent buying "best" (i.e.) tasty foods. Yet, the aim is to minimize expenditures (not effort as in subsistence, but still minimization). (For the "exchange" mode we should have a deeper look into income procurement and specify income and use of cash.) For the moment the utility (taste) aspect and satisfaction concerns. Note, internally there is labour needed in household production. A new set of shadow price is given for marginal values of the tastes (vector of preferred crops).

$$O^{u} = .5[q]' Q^{u}_{21}[q] + [p]' Q^{u}_{22}[q] + .5[p]' Q^{u}_{23}[p] + 5[\mu]' Q^{u}_{24}[\mu] + [\mu]' Q^{u}_{25}[q] + [\mu]' Q^{n}_{26}[p] - p^{1}[q] + [\mu]'[q] \quad (6)$$

Objective function (6) is a summary and flexible exposition of programing derived from an "observed" purchase of food crops q for a "tasty" consumption of food. Hereby for shadow prices μ we get valuations of q which are measured in income spent; but a problem is they are in monetary terms, and they depend on behavior in this mode of optimization. However, values μ represent again weighting (marginal utility) in case of crop purchase. Such system of optimized behavior including valuation is similar to weighting. The information which can be derived from shadow prices is similar to weighting and scoring if normalized to 100 percent.

$$\partial O^{u} / \partial[q] = Q^{u}_{21}[p] + Q^{u}_{22}[q] + Q^{u}_{25}[\mu] = \mu \quad (7)$$

As behavioural function, which gives the marginal values μ, (7) will be further processed.

## 6 Balancing, equating and adjusting

### 6.1 Dissonance as observation

So far, it was shown that shadow prices for nutrition and utility optimization can be derived giving weights to food. To bring them together (in line, i.e. to get a translation of shadow prices from one side to the other), we need to find a concept is based on consumers who appreciate utility (individualistic) and nutrition (collectivistic). The tool chosen is ranking (Schrank and Running, 2016). A concept of balancing of shadow prices (joint ranking) should enable us adjustments. Norms of nutrition shall become intrinsic and change preferences (ranking). Intrinsic means that extended welfare recognition of consumers is feasible. Utility is one thing. The allocation of efforts is another. In principle the adjustment is a way to redirect behaviour, i.e. "as if". "As if" means that comfort or well-being includes minimal differences in ranks. Shadow prices play the role of directing behaviour, though they are notified in separate optimization. Bringing them, together we suggest. Consequently, in a second step it will be outlined, how nutrition values can be part of well-being. However, the units of account are different; so we come back to the idea of weights. Remember, for the preference optimization we applied marginal utility per food unit and for nutrition optimization we got nutrition values per effort as relative weights. Ranks can matter. If we do not have a measure of income per energy it seems to be difficult to get adjustment by shadow prices. (In fact at a market, for comparison as a benchmark, prices adjust to get quantities in equilibrium having the same unit of account). But it also means ranks can come with shadow prices. Shadow prices of nutrition and utility, though having different units of account, should adjust to get evaluation in terms of constraints addressed as weights. Since the analysis is working with a programming approach and the idea is to recover behaviour of priority setting (as associated with consumption which is based on observed



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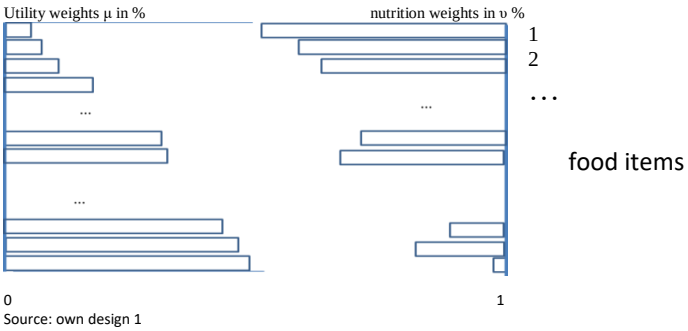
diets), still a functional approach of generalized utility and nutrition should enable us to recover the link. Diagram 1 provides a contrast ranking, first. Still, utility weight ranking might dominate and nutrition is second.

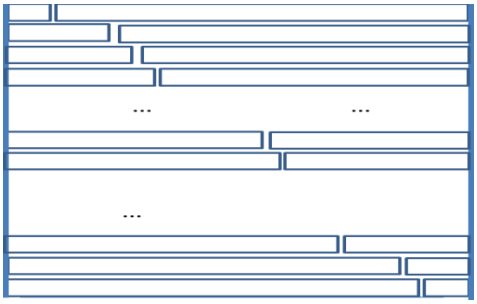
**Diagram 1a: Scores (weights) given to utility and nutrition from programming in %**




Source: own design 1

Our suggested way for recovering of joint weights is a mix of an ideal diet and an observed. We seek addressing gaps. The linkage to fill the gap shall be visualized as a transition matrix μ = A [1-υ]. Hereby it is assumed that consumers know about the conflict and valuation. They shall follow a concept of minimization of distances between values. Ideally it would end in Diagram 1b. But we have dissonances. In this respect, first, shadow prices are to be normalized such that the sum is 1. Hereby they signify a ranking or weighting which is similar to scoring; for example if 100 scores can be given, it is said that each food/crop gets a percentage or scores. The total sum must be 100 and then we can speak about per-cent scores. The scores can be considered weights. (Usually we may work with 100; if income is higher it can be expanded). Then we have weighting for the two contrasting objectives: utility and nutrition (Diagram 1c). Since scores are ranked and normed (weights) they can be compared.

**Diagram 1b: Weighting and scores (weight) perfectly fitting utility and nutrition ranking**



Source: own design

For example, if a total of 33 crops are consumed and maximum of 30 grades per crop are possible, a total rank of 999 is realized; when each crop is at highest rank. If less than total appears it is adjusted but weights stay percent as of total. A position in weights has to be found to be equal to μ (a vector and Σ μ =999). Then nutrition υ and utility μ maximization do the same specifying ranks. Diagram 1b shows a situation of perfect fit. In this case the ranking of one side is a function of the ranking of the other side. Yet dissonance (in Diagram 1) implies no fit. In Diagram 1b total fit appears. So we need a transition (matrix) to be minimized and it is guessed that the matrix can be constructed which gives the weights as linear combination μ = A[1- υ]+δ. (Note A can be equally derived from Maximum Entropy). The dissonance is an empirical observation and it is conflict driven as well as it reveals the problem of norms. Dissonance, thought, can be minimized. As background in consumer behaviour dissonance is normative if we presume consumers want to have as few as possible?

**6.2 Dissonance as concept to be minimized**

What is the cognitive and psychological background to dissonance? Since we measure differences, dissimilarities, spill-overs and consumers' leaning to altered value schemes (Thoegersen et al. 2010) dissonance is an every-day occurrence. I.e. with different weights in normative behaviour no common ranking can be expected. But humans may seek a way out by getting insights in possible adjustments (for the moment only insights and not measures to nudge). Then cognitive dissonance can equally work as concept to be looked at as minimization (Lanzini, Thøgersen, 2014,). Perhaps curing the problem is a meta-behavioural problem? But a revelation of the evidence (given as the matrix A) shall enable us to get a sensible consumer as well as a consumer who "fights" for integrity (Elster, 1983). In Diagram 1c the different dissonances are highlighted by



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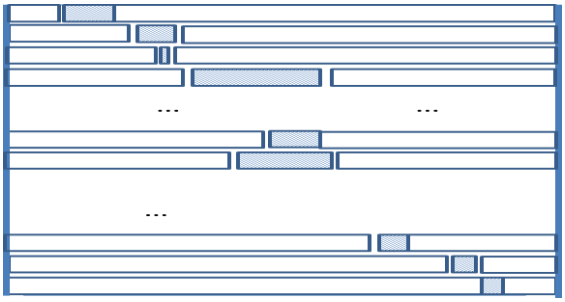
applying the earlier ranked system. Note the dominance in ranking is constituted from the utility and nutrition point of view is secondary. We keep the approach simple (for statistical purpose) and hypothesise that dissonance can be minimized. It means we chiefly address weights and we say that norms via dissonance minimization change the utility related weights. Our hypothesized analysis, though it is technical, is alike to measurement of dissimilarity (Thoegersen and Oelander, 2003) which helps consumers to address the dissonance. But, instead of only measuring, it is presumed consumers can adjust weights and the insight in consumer behaviour shall be how weights are streamlined. The chosen technique shall be a type of a quadratic deviation from a norm. Taking the construction of the weights as a ranking and the influence of norms as an orthogonal problem, it may make sense to minimize the dissonance as representation of the cognitive realization of conflicting issues (i.e. in "pursuing happiness" consumers do a meta-minimization: Cummings, Venekatesan, 1976). In our contribution it is stated that a representative consumer tries to minimize conflict by recognizing deviation and seeking to adjust weights; deviation are between weights and he minimizes them. By that weights are changed and the outcomes are new weights. Then they are changing the nutrition and utility optimization at the first stage. In fact, the nutrition norms can (shall) become "alter ego" in decision making; referring to the dissonance concept (Thoegersen, 2011) for now they only adjust. At a second stage on might also think about the welfare economic implications.

**Diagram 1c: Scores (weights) with dissonance**



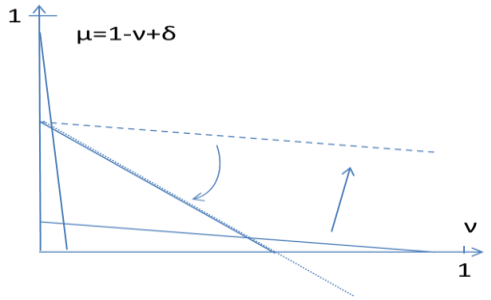
Source: own design

## 7 Minimizing dissonance

### 7.1Concept and measurement

As we work with the notion of dissonance, which is measured as distance, and see nutrition and taste as orthogonal, which gives the tension, this construction allows us portray the problem in terms of readjusting shadow prices. (Note shadow prices which are determining the consumption and come from nutrition norms are now given as weights or scores, respectively.) The case is presented in Diagram 2. It shows that the linear combination of the two orthogonal shadow prices (weights again) deliver a certain distance. For example, with a low μ (straight line below) we see a longer distance than in the case of fifty to fifty percent. Taking the parallel to the fifty-fifty line (---) and putting this line (?? ) newly on the distance
of the fifty-fifty line it becomes obvious that a longer distance appears. Either in absolute terms of in relative distance the excess is minimized. Not the excess depends on the prevalent structure of evaluation which is given as the slopes of the individual lines of the commodities used in consumption.

**Diagram 2: Minimization of dissonance as distance of values**




Source: own design

Apparently the equal weights serve as a reference. Perhaps one can expand the analysis to power of nutrition and taste; but this is beyond the current analysis, thought it might be more realistic. For the moment equal power is assumed and only the distance is minimized.



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**7.2Technical solution of minimization of distance and change of valuation**

Next, we deliver a technical outline first and then try to further make the approach plausible. At the level of cognitive dissonance vs. assonance (individual), but also at induced behaviour (social), our guess is that (though a dilemma prevails) dissonance can be minimized. In a formal approach we firstly establish a linear combination of the shadow prices as dependent on each other (we use weight or scores and shadow prices as synonym for being goal oriented assessments).

$$\mu_0 = a_{\mu 0} + A_{\mu 0}\nu_0 \tag{8}$$

Looking at the introduction of dissonance which can be changed and stating changes are not violated as a correlation, a linear combination prevails such as (9)

$$\mu_0 + \delta_\mu = a_{\mu 0} + A_{\mu 0}[\nu_{0*} + \delta_\nu] \text{ and } \delta_\nu = A_{\mu 0}^{-1}\delta_\mu + \nu_{0*} - A_{\mu 0}^{-1}[\mu_0 - a_{\mu 0}] \tag{9}$$

In that system the ranking and positioning of the contrast also matters. Then by definition a set of deviations (as vectors) are given which spells how the weights for nutrition are ordered and they must give the opposite of the weight for utility (10). To have an impact on the weights, we have to find the best (minimal dissonance).

$$I - \mu = \delta_\nu + \nu_0 \tag{10}$$

In this definition the utility maximizing unit recognizes that for its counter unit (nutrition unit) weights have to be put as deviation into place. The "help" (relief) is getting less tension (in the mental conflict). It is to adjust utility weights. The functional situation in equilibrium is:

$$\mu = I - \delta_\nu - \nu_0^* \tag{11}$$

Here the correction is $\delta_\nu$, i.e. for the utility maximizing unit. This unit would look at its own correction given the constraint.

$$\mu = I - A_{\mu 0}^{-1}\delta_\mu - A_{\mu 0}^{-1}[\mu_0 - a_{\mu 0}] - \nu_0^* + \nu_0 \tag{12a}$$

But the nutrition unit wishes the same. I.e. the same applies to the other side (nutrition)

$$\nu = I - A_{\nu 0}^{-1}\delta_\nu - A_{\nu 0}^{-1}[\nu_0 - a_{\nu 0}] - \mu_0^* + \mu_0 \tag{12b}$$

And finally it is stated that the deviations are of equal importance and minimized jointly.

$$\text{Min } \delta^2 = \delta_\mu{}^2 + \delta_\nu{}^2$$

After inserting a function of adjusted weighting the optimization problem is due to:

$$\text{Min } d = \delta^2 = [I - A_{\mu 0}^{-1}\delta_\mu - A_{\mu 0}^{-1}[\mu_0 - a_{\mu 0}] - \nu_0^* + \nu_0]^2 + [I - A_{\nu 0}^{-1}\delta_\nu - A_{\nu 0}^{-1}[\nu_0 - a_{\nu 0}] - \mu_0^* + \mu_0]^2 \tag{13}$$

And we can optimize (minimize distance) as a new finding of weights. As a result we get:

$$\partial d / \partial \delta_\mu = 1/2 \; 1/[\ldots]^{1/2}\, 2[I - A_{\mu 0}^{-1}\delta_\mu - A_{\mu 0}^{-1}[\mu_0 - a_{\mu 0}] - \nu_0^* + \nu_0] = 0$$

and

$$\partial d / \partial \delta_\mu = 1/2 \; 1/[\ldots]^{1/2}\, 2[I - A_{\nu 0}^{-1}\delta_\nu - A_{\nu 0}^{-1}[\nu_0 - a_{\nu 0}] - \mu_0^* + \mu_0] = 0$$

Finally we get the adjusted weights μ and ν; they can be recalculated which gives us an adjusted $\mu^{a.}$. The adjusted $\mu^{a.}$ becomes a driver for a norm revised consumption of food crops.



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**7.3Nutrition sensitive consumption derivation from adjusted weighting (valuation)**

Notice, since , because of adjusted weights in the objective function, weights change the behaviour and consumption changes subsequently. For this purpose we insert $\mu^a$ in objective function (6)

$$O^u = .5[q]' Q^u_{21}[q] + [p]' Q^u_{22}[q] + .5[p]' Q^u_{23}[p] + 5[\mu^a]' Q^u_{24}[\mu^a] + [\mu^a]' Q^u_{25}[q] + [\mu]' Q^n_{26}[p] - p'[q] + [\mu^a]'[q] \quad (14)$$

Then the first derivative gives a new demand of crops as been driven by nutrition norms as well as prices.

$$\partial O^u / \partial[\mu^a] = Q^u_{24}[\mu^a] + Q^u_{25}[q] + Q^n_{26}[p] + [q] = 0 \quad (15)$$

As behavioural function, which gives the "adjusted" demand" equation (15), can be also traced back to the nutrition norm. It is the combination of an adjusted norm concept. Supposedly it is a type of a meta-equilibrium which recognizes dissonance as soft power.

## 8 Interpretation and Implications

From the above analysis an interdependent "balancing of weights" can be obtained in which shadow prices are modified. In that regard a correction of behaviour is achieved which gives modified decision. In contrast a liberal economist will see no reason for change. However as a synthesis, a hedonist-public economist will relate the dissonance to future health costs and he will plea for correction mechanisms. So it comes to the question of institutions backing behavioural change. Moreover there is psychology and cognitive science as part of social processes as well as flexibility as part of expressing preferences (involved perhaps in consumer culture: (Szmigin et al. 2009). In that manner there seems to be a spectrum which permits dissonance and dissonance can be imbedded into system (Meadows and Wright, 2008) Tastes are stock variables slowly changing. For our analysis, which is comparative static, the minimization of dissonance does not mean that there is no more. The mere inclination is that a "rational" citizen-consumer tries to minimize it. I.e. dissonance is minimized at no cost. Perhaps one can include costs of dissonance and that will broaden the analysis. Combing normative and positive analysis is an explanation. By including processes at society level it may unfold outlooks for "rational" interventions. Interventions, per se, should not to be rejected because of methodological individualism, instead collective knowledge of "recipes/guidelines" matters. Then the question is how do norms ("collective guidelines") come to notice? In our hybrid version of optimization nutrition, the optimal is not independent; "real utility" maximization can (must) be diverse for any individual consumer.

(2) Has this impact at the market level? In cost-benefit-analysis, the marginal consumer determines the prices which are equal to marginal costs; yet in a cost version the "quality" of food with regards to nutrition norms is not recognized because only quantity matters. With the nutrition norm inclusion the "marginal consumer position" may change, i.e. if we have different consumers reacting differently to norms, who is a marginal buyer? The immediate question thereafter is: is there scope to an approach in which dissonance gets recognition at the supply level? The aim might not be that a "normal" consumer minimizes dissonance; rather a marginal consumer and the supply should individually address consumers as "norm" oriented. Again, this raises a question what is dissonance and is it part of, perhaps virtual, welfare of a higher dimension? A query is, can dissonance be traded rationally and actually be minimized through better foods? In other word, can we create incentives which stimulate supply to reduce dissonance? In marketing, at least, cognitive dissonances count. Currently marketing strives primarily for dissonance in utility and sells virtual esteems at commodity level. Because of commodification problems, nutrition aspects seem to be not profitable; they are considered minor; especially because they do not translate into money easily.

(3) It needs reducing dissonance and getting sales. Yet, in the case of promotion within given foods and promotion of a newly to be introduced, nutritious food must be distinguished. A cost-benefit-analysis of, for instance, a very nutritious food (crop) may matter more than working with given diets. For instance let us look at introduction a nutritious, special food (eventually a fruit like avocado, though avocadoes are blamed as sales promotion) which is a new consumer want. Like in programming, increased fulfilments of nutrition (for comparison see farm profit analysis) can be obtained by diversification in economics. The difference is that not a single set of food is derived from established crops/foods (bought at given nutrition value in a diet to be pursued); rather flexibility has to be built in sets. Since optimization is taste and nutrition oriented, anchor commodities are to be recognized. An easy way is to look at food with similar preference for taste, but higher nutrient load, and then substitute it in terms of an experiment. This will change both, ranking and the shadow price after adjustment.



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(4) What is the currency of exchange? If there is a willingness to "pay" to get rid of dissonance what is the remuneration a suppler looks for? Actually in the given context of seeking a relief of dissonance, less dissonance can be translated into monetary terms. Since we have the units and the shadow prices to tell marketing what is the wish of the customer for a new product, there is scope to create a market for such service. The recipient of money as a provider of service, nonetheless, must offer something which relates to better diet and this hopefully will make nutrition norms a tradeable secondary feature of a commodity. If the consumer accepts better dietary recipes of purchased foods (i.e. the foods contain more nutritious ingredients as compared to standard) the quality per unit is improved, and there is a mutual benefit. An amendment could be that the industry thinks about intermediary products which upgrade standard in a way that new things come to markets being more nutritious. Knowing the consumer response in terms of dissonance reduction there is scope to formulate goods as imposing reduced dissonant.
However, the supply side was not the focus of this contribution; rather reduced dissonance as measure to understand nutrition sensitive consumption. Yet the nutrition aspect comes in by norms. We assumed suppliers know trade-offs and norms and can strive for "better" standards; but what are the costs to him (reduced profits)? Suppliers can modify foods; perhaps they offer change to gather a premium on dissonance. But this is not sufficient, if price levels are not changing and competition supports low quality. As for any marketing investigation commodity values and passions must be distinguishable. The preferred value is, in our case, reduced dissonance and consumers are willing to pay for it (this is the assumption).

## 9 Policy implications and limitations

A pertinent question is: is it realistic that consumers will reveal a willingness to pay for reduced dissonance which is influenced by norm setting? We think: yes; but it needs help through standardized diet recognition and product control being an element of public recognition and intervention. An observation is already that so called "social responsibility" is part of marketing; for instance, concerning saving the environment, animal welfare, etc., things emerge. This shows that consumers are willing to get rid of a bad consciousness. It may also relate to dissonance. Yet, it has to be extended to nutrition. The nutrition dissonance concept may show potential if picked up by a firm, which assure specificity of a product. Then, other firms must follow to stay competitive. How can this potential scope be translated into action? A market scope is creation of a secondary market for dissonance (reduction) which must be promoted by health concern and not fall under consumer misleading? Governments are requested to assure rights on nutritious foods. As usually said, rights, transparency, and even patents are important. But it is unclear, how dissonance reduced foods can be legally specified?.Public authorities should be involved in campaigns and, in particular, scrutinizing options of product innovations (dietary implication) according to information on norms. Innovations should be on health and advertised in local clubs or consumer get-togethers. The issue is that not all consumers, per se, are responsive to dissonance reckon. Some can be addressed by awareness campaigns, not all. A categorizing of consumers is needed, especially to find marginal willingness to pay in dissonance. It brings us to the question of extreme? In public health, obesity, micro-nutrient deficits, etc. are topics. If it comes to disadvantaged, industries are reluctant about norms. But they may gain with reduced dissonance. But consumers may fail to acquire dissonance. Some people might be identified not to acknowledge dissonances because they are not sensitized. They may change opinion, if products become available which are "valuable" in their eyes (less dissonance). The author thinks that it is short-sighted industry cannot come up with nutrition sensitive consumption as public good.

## 10 Summary

This paper deals with an innovative approach to link nutrition and utility optimization by referring to norm setting in diets and dissonance between preference and nutrition concerns. It works with a programming approach on specifying and revealing behaviour of observed purchase of food as well as nutritional optimal food purchases. As a result we receive shadow prices for nutrition and chosen diets. Shadow prices are translated into weights (scores) and weights are normalized using ranks for nutrients and crops used in diets. Then we expand on a newly suggested way to link weights through a dissonance measure. Dissonance is constructed by a transfer matrix and the relative position of nutrition and utility weights. Dissonance is minimized and finally it is suggested how to translate weights into marketing improvements for nutritious foods. A finding is that dissonance can be an immaterial attribute which becomes tradeable. This has implications for competition between suppliers who currently only seek to cater consumers' preference. Also policy implications are discussed suggesting that collectively promoted recipes can be a vehicle for nutrition sensitive consumption. The analysis needs to be expanded to different consumer types and we need a categorization of type-specific addressing of deficits and dissonance which should be minimized.



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