The Impact of Price Intervention Policies to Improve Dietary Quality in Spain

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Abstract

The objective of this paper is to assess the effectiveness of price intervention policies to modify food demand in Spain as well as the Spanish dietary quality. The methodological approach is based on the estimation of a food demand system based on consumers' maximisation of an utility function, which depends on, both, food quantities and the level of health reached by consumers, subject to two restrictions: a budget constraint and a health production function. From the estimated elasticities two alternative scenarios are considered: 1) decreasing taxes on Fruits and Vegetables; and 2) increasing taxes on Meat. Results indicate that taxes (subsidies) would not affect overall dietary quality of the average consumer. However, this policy can be used to get additional public funds to finance educational campaigns or complementary health policies.

Key words: Dietary quality, Food demand, taxes, Spain.

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1. Introduction

During the last few decades, food diets have transformed substantially as a result of multiple factors from which technical change along the food chain has played a pivotal role. In fact, the modernization of the food chain has increased productivity and resulted in three major consequences: 1) increasing excess supply and decreasing real food prices; 2) a deep industrialization of agrarian societies helping them to accumulate capital, free up labor and provide more nutritious and value added food; and 3) a substantial transformation of citizens' lifestyles as a consequence of rising income, urbanization and changes in food sector (globalization of the food industry and retailing sectors, fast-food, e-commerce,…).

These changes have generated two important consequences on food demand. On one hand, as Gil *et al*. (1995) show, declining real food prices has generated not only an increase of total calorie intake but also a shift towards a higher calorie density diet that is richer in cholesterol and saturated fats (i.e. higher consumption of meat, eggs, dairy products and sugar). On the other hand, the increasing sedentariness has made calories expenditures to decline. As a result of both trends, food diets in most developed countries are clearly imbalanced having generated a rapid increase of the prevalence of overweight, obesity and related non-communicable diseases.

The World Health Organization (WHO) estimates that worldwide there are 1 billion overweight adults and, at least, 30% of them are obese (WHO, 2005). Although the WHO characterizes overweight and obesity as diseases, it is also well known that both (together with smoking) are key determinants in the incidence of the most important contemporary chronic diseases, such as cancer, cardiovascular problems, certain types of diabetes, etc. Obesity accounts for 7% of total health care costs (WHO, 2005) without considering other economic externalities, which, on the other hand, are difficult to estimate.

Within the EU, Liu *et al*. (2002) estimated that, in the United Kingdom, costs associated with coronary heart diseases were 7.06 billion pounds, where 24.5% corresponded to health care costs, 41.2% to informal treatments and the rest to productivity losses. However, calculations did not include how much was due to obesity. In Germany, Kurscheid and Lauterbach (1998) estimated that indirect costs associated to obesity represented around 4% of total health care costs. In Spain, the Spanish Society for the Study of Obesity (SEEDO) estimates that direct and indirect obesity costs account for 7% of total health care costs (2.5 billion Euros/year).

While there exists in Europe an increasing concern about risks associated with imbalanced diets and obesity as well as their economic impacts, the policy response has been developed rather slowly and does not seem to have had a significant impact on market trends (Mazzocchi and Traill, 2005). Although there is not currently a common health policy, there are some broad guidelines and action plans that can guide national interventions. As a result, the picture is different among EU countries. In general terms, northern countries have implemented more effective policies than southern countries, who have underestimated the problem by claiming the advantages of their traditional Mediterranean diet.

Nutrition policies in the past have concentrated on information and education strategies, which have been shown not to be very effective in rebalancing diets during the last decade. The objectives of health policies are often at odds with those from more consolidated food policies, such as agricultural and trade policies. Moreover, food habits are the result of a complex mixture of different factors (socio-economic and environmental factors, lifestyles, culture, traditions,…), which, in many cases, are very difficult to change with non-coercive measures. In the United States, some researches and health policy advocates have started to demand more prescriptive measures to tackle food diets (Kuchler *et al*., 2005). Among these measures, price intervention policies are becoming very popular. Price interventions consist of taxing unhealthy products and subsidizing healthy products in order to directly influence consumers' diet and health or, if they are not effective, at least, to finance information programs to help consumers to choose a healthier diet.

The objective of this paper is to assess the effectiveness of price intervention policies aimed at modifying food demand and diet quality in Spain. To achieve this objective, price elasticities are crucial to forecast potential impacts of changing prices.

A food demand system is specified and estimated assuming that consumers maximize a utility function, which depends on food quantities and the level of health reached by consumers, which is subject to two restrictions: the traditional budget constraint and a health production function. Household data from the Spanish Quarterly Household National Expenditure Survey are used to tackle this issue.

This paper is structured as follows. In the next section, some trends on food demand in Spain and the prevalence of obesity are outlined. An overview of public policies addressed to reduce obesity and improve diet quality is provided in Section 3. Section 4 deals with the methodology used in this paper. The description of data used is presented in Section 5. Estimated parameters and calculated elasticities are shown in Section 6. The assessment of price intervention policies is carried out in Section 7. The paper ends with some concluding remarks.

2. Food consumption in Spain and the prevalence of obesity

The structure of Spanish food demand has stabilized in the last few years. According to data from the Quarterly Household National Expenditure Survey for 2003, the average budget shares of different food groups in relation to total food expenditure were: cereals and potatoes, 16.2%; meat, 24.5%; milk and dairy products, 13.8%; fruits and vegetables, 20.4%; fish, 13.9%.; and, finally, vegetable oils, 11.13%. However, important family differences appear in relation to certain household characteristics, as shown in Table 1.

In larger towns, households spend a relative higher percentage in fish, fruits and vegetables and meat, while the consumption of cereals and potatoes, dairy products and vegetable oils are lower. In relation to the education level, it is interesting to note that as the level of education increases, the relative importance of the consumption of cereals and potatoes and vegetable oils diminishes, although more significantly in the first case. On the opposite side, higher education levels are associated with higher budget shares allocated to meat, fish and fruits and vegetables.

In general, households with children have a higher budget share for cereals and potatoes, meat and dairy products. On the other hand, the percentage allocated to vegetable oils and fruits and vegetables is higher in one-person households and in households without children. In relation to the age of the head of the household, there exists a positive relationship between age and the consumption of fruits and vegetables and vegetable oils, while younger households are associated with higher budget shares allocated to cereals and potatoes, meat and fish. Finally, no big differences are found when accounting for the sex of the head of the household.

The extent of the obesity problem in Spain is converging to that in most EU countries (Table 2). Around 13.4% of males and 15.75% of females are obese (Body Mass Index (BMI) above 30). Surprisingly, the problem is more severe in females. On the other hand, the overweight population in Spain (BMI between 25 and 30) includes 44% of males and 32% of females.

The average obesity rate covers significant differences among socio-demographic groupings of the population. For example, Aranceta *et al*. (2003) show that there exists a direct relationship between age and the prevalence of obesity, reaching 21.6% and 33.9% for males and females over 65 years old, respectively. Also significant differences have been found taking into account geographical location, urbanization, and income and education levels. The prevalence of obesity is more important in Galicia, Andalucia and the Canary Islands, in rural areas and in groups with lower education and income levels.

Although figures for adults are not very different to that for other countries, the key concern seems to be the potential rise in obesity which can be forecasted by evaluating the rates of overweight children in Spain. The prevalence of obesity among the population between 2 and 24 years old is 13.9%, while the overweight rate reaches 26.3%. Moreover, the prevalence of obesity in children between 6 and 12 years old is 16.1%, which is one of the highest among EU countries.

3. Public policies to improve diet quality and reduce obesity

The increasing obesity problem has now become a public health problem that deserves attention from public authorities in order to implement policy measures to have an impact on food consumption and the quality of diet. Market interventions are traditionally justified to correct for market failures (i.e. externatilities associated to increasing public health costs,...). A recent body of literature also justifies market intervention from the notion of paternalism since individuals may have potential self-control problems or time inconsistent preferences underlying the consumption of unhealthy food, thus not behaving as fully rational (O'Donoghue and Rabin, 1999; Cutler *et al*., 2003; and Aronsson and Thunström, 2005). The underlying idea is that individuals, at any time, when solving potential tradeoffs between present and future utility, may apply a higher utility discount rate than that they would apply to similar tradeoffs in the future. In other words, individuals derive immediate gratification from food consumption without recognizing the health costs of over-consumption that takes place only in the future. Finally, Cawley (2003) also justifies market intervention based on information asymmetry: individuals have a lack of knowledge about the potential consequences associated with certain diets.

In spite of the need for market intervention, the role of public authorities in Spain to manage obesity has been so far restricted to information campaigns which have not been very effective in reducing the high prevalence of obesity among children. However, in the last Spanish legislature, Spanish health authorities demonstrated a willingness to get involved by setting explicit policies to address the problems and causes of obesity. Table 3 shows a wide range of potential instruments available to public authorities (Mazzocchi and Traill, 2005). Policies are classified in four groups according to their expected impacts on economic agents: 1) policies addressed to change consumers' preferences; 2) those aimed at a better-informed choice without affecting consumers' preferences; 3) market policies addressed to affect actual choices; and 4) supply-side policies affecting availability.

As can be observed the number of potential alternatives is very large and, at the same time, they are very heterogeneous in nature, which, on the other hand, merely reflects the complexity of the problem and the number of factors influencing dietary habits and intakes (individuals' socioeconomic characteristics and lifestyles). Moreover, it is also true that food policies addressed to the emerging nutrition challenges need to coexist with agricultural and trade policies, which have traditionally regulated the agro-food activities with very different objectives. Such coexistence may reduce the effectiveness and complicate the implementation of some of the instruments shown in Table 3.

Since any single instrument can not be effective by its own, Nestlé (2002) suggest five simultaneous changes in public policies intended to improve the quality of diet and to reduce obesity: education reforms, food labeling and advertising reforms, health care and training requirements, transportation and urban facilities requirements, and tax policy reforms (increasing taxes for unhealthy foods and subsidies for healthy ones,...). Among these suggested changes, the analysis of the potential impacts of the last one deserves special attention within empirical literature (Marshall, 2000; Battle and Brownell, 1996; Kuchler *et al*., 2005; Schroeter *et al*., 2005; Simed and Denver, 2005; among other) and is also the main objective of this paper.

In general terms, tax reforms can adopt the following two formats:

- Measures addressed to change the relative price of foods, making healthy foods cheaper relatively to unhealthy ones. There exist two ways of doing this. The first one is reducing the Value Added Tax on some healthy products and/or increasing on unhealthy ones. The second is modifying taxes for healthy/unhealthy components of food (saturated fat, cholesterol, fibers, etc.). Among the two alternatives, as food items typically contain a group of different nutrients, a tax on a food item rather than on a nutritional component could generate undesired side-effects. For instance, Guo *et al*. (1999) concluded that increasing pork prices in China would reduce the energy calorie intake of richer consumers but would also reduce the protein intake by the poor. However, Jacobson and Brownell (2000) and Schmidhuber (2004) conclude that in practice such a tax/subsidy would have to be imposed on foods items rather than on nutrients as the second one would be politically unfeasible as legislators would prefer to establish tax rates for entire classes of foods rather than taxing an attribute.
- A tax on excess body weight (a tax on obese people) based on the social costs that obese people cause to society. Although it can be thought to be a politically incorrect measure, it is also true that we have many situations in real life in which this kind of “disincentives” already exists. In USA, health and car insurances have started to offer discounts on premiums for clients with normal body weights (Schmidhuber, 2004) or fast food chains are introducing implicit taxes on overweight people by rejecting obese job applicants (Greenhouse, 2003).

Even though there is a consensus that a tax on excess body weight would be more effective than price interventions, it may not be without pitfalls. First, this measure, to be effective, needs a substantial reduction of the information asymmetry between consumers and the food industry. Second, a reduction in the Body Mass Index, may not lead directly to a reduction of health problems as the way individual have chose to lose weight can generate other health side-effects. Finally, and probably the most important, these type of measures still are polemic and generate a lot of social controversy. Mainly for this reason, in this paper we are going to concentrate on the potential impacts of price interventions on food consumption and the quality of the diet.

Price interventions could be at the producer or at the consumer levels. In this paper we focus on interventions at the consumer level for two main reasons. First, interventions at the producer level have been subject to controversial policy debates (intervention price systems, export subsidies and border protection). In this context any intervention for the sake of possible health benefits would generate hard negotiation within the World Trade Organization. Second, interventions at producer level require perfect price transmission along the food chain, which is the exception (see, for instance, Meyer and von Cramon-Taubadel, 2004, for a literature review on this topic).

The next sections will focus on the extent price interventions, at the consumer level, are effective in improving the quality of diet and modifying food demand to healthier products in Spain.

4. Methodology

4.1. Theoretical framework

As mentioned in the introduction, the main objective of this paper is to assess the potential impact of price interventions on a better balanced diet in Spain. This objective is achieved through simulations from estimated price elasticities. Thus, as a first step, we have specified and estimated a food demand system. To obtain such a system we have considered that consumers maximize a utility function which depends on both food quantities and the level of health reached by consumers:

$$\text{Max } U = U(q_1, q_2, ..., q_n, H) \qquad (1)$$

where q_i represents the quantity consumed of the i[th] good and H is the level of health reached by consumers, subject to two restrictions:

$$\mathrm{H} = \mathrm{h}(\mathrm{I}, \mathrm{u}) \qquad (2)$$

$$m = \sum_{i=1}^{n} q_i p_i \qquad (3)$$

Expression (3) is the traditional budget restriction where m represents food expenditure and p_i the price of the i^{th} good. Expression (2) denotes the health production function depending on several inputs where I is a measure of the quality of the diet and u includes non-observable determinants of health[1]. Furthermore, the quality of diet (I) can be considered constrained ("production technology") and expressed as: I = WP·q, where WP is a matrix of weights that represents the mechanism to obtain the quality of diet from quantities consumed.

Maximizing (1) subject to (2) and (3) generates, on one hand, the food demand equations:

$$q_i = g_i(m, p_1, p_2, ..., p_n, I, u) \qquad i = 1,........,n \qquad (4)$$

and, on the other, the demand for health:

$$H = f(m, p_1, p_2, ..., p_n, I, F, u) \qquad (5)$$

However, for the purposes of this paper, we will concentrate on food demand equations expressed in (4).

4.2. Functional form

In this paper, we have chosen a Generalized Addilog Demand System (GADS), initially proposed by Bewley (1986) and Bewley and Young (1987) based on Theil (1969). The GADS model assumes that budget shares (w_i) have the following structure:

$$w_i = \frac{e^{g(x,\beta_i)}}{\sum_{j=1}^{n} e^{g(x,\beta_j)}} \qquad i = 1,...,n \qquad (6)$$

where: $$g(x,\beta_i) = \alpha_i + \beta_{i0} \ln m + \sum_{j=1}^{n} \beta_{ij} \ln p_j + \gamma_i \ln I$$

and x is the vector of explanatory variables: food expenditure (m), prices (p_j) and health inputs (I); β_i are parameters to estimate; and n is the number of goods.

[1] H can also depend on other factors non-directly related to food as medical care, physical, exercise, etc. However, as data sources used in this paper do not include information on these variables, we have excluded them in the theoretical framework to make the empirical section consistent with this one.

Model (6) is difficult to estimate, however, by taking logs and making some transformations (Bewley and Young, 1987) we get the following linear version of the GADS model, which allows us to more easily estimate the parameters and test and/or impose theoretical restrictions (homogeneity, symmetry and negativity):

$$w_i \ln(\frac{q_i}{W}) = a_i + \theta_i \ln(\frac{m}{P}) + \sum_{j=1}^{n} s_{ij} \ln p_j + k_i \ln I \qquad (7)$$

where: $\theta_i = w_i \eta_i$ (being η_i the income elasticity) and $s_{ij} = w_i \varepsilon_{ij}$ (being ε_{ij} the compensated price elasticity) are the marginal budget shares and the Slutsky parameters, respectively; $k_i = w_i \sigma_i$ (being σ_i the health input elasticity) and ln P is the linearized Stone price index.

In (7) parameters θ_i and s_{ij} are assumed to be constant. However, there is no strong *a priori* reason for such restrictions. An alternative parameterization is based on Working's Engel model:

$$w_i = c_i + b_i \ln m \qquad (8)$$

from which it is possible to derive the marginal budget shares, θ_i , by multiplying (8) by m and then differentiating with respect to m:

$$\frac{\partial (p_i q_i)}{\partial m} = c_i + b_i (1 + \ln m) \qquad \text{or} \qquad \theta_i = w_i + b_i \qquad (9)$$

Expression (9) implies that, under the Working's model, the *i*th marginal budget share differs from the corresponding budget share by b_i. As the budget share is not constant with respect to food expenditure, neither is the associate marginal budget share.

Substituting (9) in (7), and acknowledging that $\ln Q = \ln m - \ln P + \ln w$, we get the GADS-CBS model for the purpose of this paper:

$$w_i \ln(\frac{q_i}{Q}) = a_i + b_i \ln(\frac{m}{P}) + \sum_{j=1}^{n} s_{ij} \ln p_j + k_i \ln I \qquad (10)$$

The socio-economic characteristics of households have also been introduced in (10) by modifying the intercepts, as proposed by Pollack and Wales (1981). Finally, from estimated parameters, the following elasticities will be calculated:

- Expenditure elasticity: $\eta_i = 1 + \frac{b_i}{w_i}$

- Compensated price elasticities: $\varepsilon_{ij} = \frac{s_{ij}}{w_i}$
- Uncompensated price elasticities: $\mu_{ij} = \varepsilon_{ij} - w_j \eta_i$
- Elasticity of the quality of the diet: $\sigma_i = \frac{k_i}{w_i}$

5. Data

Data come from the Spanish Quarterly Household National Expenditure Survey, which provides quarterly information on the expenditure and quantity of various classes of food products consumed by a stratified random sample of 3,200 households. Each quarter, information is collected from every selected household during one week. Theoretically, one household stays in the survey for eight quarters. However, in practice, only a few households stay in the sample for the maximum period. So, for this study, we have only included those households that participated along the year in question, 2003. Moreover, we have eliminated those households with no expenditures in all good categories or where food expenditures are lower than 2% of total expenditures. This strategy has led us to a final sample of 1,657 households, where consumption is aggregated over the four quarters. The following food groups[2] are considered: 1) cereals and potatoes; 2) meat; 3) dairy products; 4) fruits and vegetables; 5) fish; and 6) vegetable oils.

Since prices are not explicitly recorded, unit values for each group are calculated by dividing expenditures by quantities. These values may reflect not only spatial variations caused by supply shocks (i.e., transportation costs, cost of information, seasonal variations, etc.) but also differences in quality which can be attributed to brand loyalty or marketing services among other factors. Then, unit values have been adjusted following Gao *et al*. (1997). The quality-adjusted price is defined as the difference

[2] Data on expenditure was available for all items within each food group or category. However, data on quantities was not available for all items. Within each group we were able to account for quantities that correspond to the following percentage of total expenditure for that group: cereals and potatoes, 58.63%; meat, 58.61%; fish, 60.52%; dairy products, 72.56%; vegetable oils, 83.09%; and fruits and vegetables, 76.24%.

between the unit price and the expected price, given its specific quality-related characteristics[3].

The expected price is calculated by the following hedonic price function:

$$U_j = \vartheta_j + \sum_s \iota_s V_{js} + \varepsilon_j$$

where U_j is the unit value and V_{js} are the variables affecting the consumer choice of qualities, such as income and household characteristics, which are used as proxies for unobservable household preferences regarding the quality of the good. Regional and seasonal dummy variables are not included because although they reflect systematic supply variations, their average effects are reflected by the intercept ϑ_k. Putting all this together, the quality-adjusted price is then:

$$p_j = U_j - \sum_s \hat{\iota}_s V_{js} = \hat{\vartheta}_j + \hat{\varepsilon}_j$$

The survey also gathers information on a limited number of household characteristics including the level of education and main activity of the head of the household, household income, household size, age and sex of family members and town size, among others. In relation to vector I, the survey does not include information on health factors not directly related to food. Thus, we have restricted our analysis to the quality of diet.

6. Empirical results

6.1. The Quality of Diet Index

In this paper, we have assumed that a diet will be of higher quality if it contributes to strength the consumer's health status. In this context, we have measured the quality of diet as a weighted average of deviations between the consumers' overall intake and the WHO and experts' recommendations for five nutrients: 1) carbohydrates; 2) lipids; 3) proteins; 4) fiber; and 5) cholesterol, following a similar approach than in Variyam *et al*. (1998). As the available data set only provides information at the

[3] In those cases where unit values do not exist, as when households do not buy the specific product, these values have been estimated using a regression on the observed unit values of households which actually buy the product on dummy variables reflecting household characteristics such as region, season and income. The estimated parameters are then used to predict unit values for a specific household.

household level, per capita intake has been obtained by dividing total household intake by the number of adults’ equivalent. The intake of carbohydrates, lipids and proteins are measured as a percentage of total energy intake. The other two are measured in grams and milligrams, respectively.

Two main sources of recommendations have been used. First, we have considered the FAO/WHO/UNU(2004) recommendations, which provide desirable intake levels for the different nutrients considered in this paper. Second, we have used the recommendations made by nutritionists who define lower and upper intake threshold levels, outside of which health problems can be serious. As we are dealing with the Spanish population, we have chosen for this purpose a study made by a group of Spanish nutritionists (Mataix, 2002). Table 4 shows the recommended values from both sources. Such recommendations lead to constructing the Index which has been built for each nutrient and for each household:

- 20 points are assigned if per capita (adult equivalent) intake lies between the WHO recommended values
- 0 points are assigned it per capita intake is out of the thresholds suggested by nutritionists
- Proportional values between 0 and 20 are assigned depending on how far /close is per capita nutrient intake in relation to WHO recommendations and nutritionist’ thresholds

Finally, values for the five nutrients are aggregated. As can be observed, the Diet Quality Index (DQI) lies between 0 and 100. Higher values indicate a better diet. Table 5 shows the contribution of each nutrient to the index and aggregated values for different socio-economic groupings. For Spain, the DQI is 46.7. In general terms, the Spanish diet is adequate in terms of cholesterol (16.1 out of 20) and, to a certain extent, proteins (13.0). However, it is clearly imbalanced in terms of carbohydrates (4.6), lipids (5.6) and fiber (7.4). In relation to socio-economic characteristics, it is quite interesting to note that the situation in Spain differs from that existing in other EU countries. In Spain, people living in smaller towns (rural areas), with lower education levels and with larger families show a better diet quality. The traditional Mediterranean diet seems to persist in rural areas and lower welfare households while more developed societies have converged towards the more “unhealthy” northern European countries diets.

6.2. Model estimation

The food demand system has been estimated assuming endogeneity of the Diet Quality Index. As a first step, alternative specifications have been tested for the DQI. We have not found any evidence of non-linearities between the Diet Quality Index and food expenditures. Then, the Box-Cox transformation has been used to choose among alternative functional forms. Results indicated that the semi-log functional form better fitted the data. As a second step, the food demand system has been estimated by Three-Stage Least Squares using the estimated index as the instrumental variable. The final estimated equations are given by[4]:

$$I_i = \chi_{0i} + b_i \ln m + \sum_{j=1}^{n} s_{ij} \ln p_j + \phi_i G + \omega_i H + \zeta_i J + \nu_i L + \varpi_i M + \sum_{r=1}^{3} \upsilon_{ir} N_r + \sum_{s=1}^{3} \rho_{is} R_s$$

$$w_i \ln(\frac{q_i}{Q}) = a_i + b_i \ln(\frac{m}{P}) + \sum_{j=1}^{n} s_{ij} \ln p_j + k_i \ln I \qquad (11)$$

$$+ \phi_i^{'} G + \omega_i^{'} H + \zeta_i^{'} J + \nu_i^{'} L + \varpi_i^{'} M + \sum_{r=1}^{3} \upsilon_{ir}^{'} N_r + \sum_{s=1}^{3} \rho_{is}^{'} R_s$$

where: G is the percentage of children within the household; H, is the percentage of teenagers; J, is the percentage of adults; L, is the percentage of males; M, indicates the household size; N_r, are dummy variables which take the value 1 if the head of the household has a level of education r, and 0, in other case (r= primary, secondary and university)[5]; R_s, are dummy variables which take the value 1 if town size is s, and 0, in other case (s= 10,001-50,000, 50,001-500,000, > 500,000 inhabitants) [6]; and the rest of the variables have been already defined.

6.3. Elasticities

Several types of elasticities have been calculated from the estimated model. Table 6 shows the elasticities of the Diet Quality Index with respect to food expenditure and prices. As can be observed, the quality of diet is getting worse as food expenditures

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[4] Estimated parameters are not included due to space limitations. Moreover, in the demand system theoretical restrictions have been imposed as results from tests indicated that the null could not be rejected

[5] The reference category is "without studies"

[6] The reference category is towns with less than 10,000 inhabitants.

as well as cereal and potatoes and dairy prices increase. On the contrary, an increase of vegetable oil prices improves diet quality.

Food expenditure and uncompensated own-price elasticities, calculated at mean values, are shown in Table 7[7]. All expenditure elasticities are positive and significant at the 5% level of significance. Meat and dairy products can be considered as luxury goods in relation to total food expenditures (when total food expenditures increase, the allocation to such products increase more than proportional). Elasticities for cereals and potatoes and fruits and vegetables are close to unity (0.97 and 0.99, respectively). The obtained results are quite consistent with expectations. Perhaps, in the case of fish it would be expected higher values because those products used to be high-priced. However, nowadays the market share of farm fish has substantially increased pushing average prices down.

All uncompensated own-price elasticities are negative and significant. In general terms, the demand for the different products are quite inelastic, except in the case of milk and dairy products. Finally, food demand elasticities with respect to the quality of the diet are also shown in Table 7. As can be observed, a positive (negative) variation of the Diet Quality Index increases (decreases) the demand for cereals and potatoes, and milk and dairy products while decreases (increases) the demand for meat, fish and vegetable oils. These results are quite consistent with previous expectations as cereals and potatoes are main providers of carbohydrates and fiber, while meat and vegetable oils are main suppliers of lipids. The demand for fruits and vegetables is not significantly affected by changes in the Diet Quality Index.

7. Effects of price interventions

As mentioned in Section 3, we have considered changes in prices at the consumer level by modifying indirect taxes (Value Added Tax (VAT)). In Spain, VAT is set at 16% for most products. However, necessities like bread, milk, eggs, fruits and vegetables and potatoes are taxed with 4%, while for the rest of food products the VAT is 7%. Two scenarios have been simulated:

- Decreasing taxes on Fruits and Vegetables (from 4% to 1%)

[7] Compensated price elasticities are not shown due to space limitations but they are available from authors upon request.

- Increasing taxes on Meat (from 7% to 16%)

In both scenarios, we have assumed that the food supply is competitive and that there are not specialized inputs (i.e. marginal and average costs remain constant). Under these assumptions, any price change will be fully passed forward to consumers (Kuchler *et al*, 2005). Own- and cross-price elasticities have been used to make the simulations assuming that total food expenditures remain constant. We will focus our analysis to the impact on: 1) Quantities consumed; 2) the Diet Quality Index; and 3) the Public Budget. Total expenditure has been assumed to remain constant.

Effects on quantities consumed and on the public budget of both scenarios are shown in Table 8. As can be observed, subsiding fruits and vegetables generates a double effect. On one hand, there is a positive effect on their demand. On the other, the real income rises (income effect), increasing the demand for meat and decreasing the demand for the rest of the products. In any case, income effects are quite inelastic. Similar effects are observed for the second scenario. In this case, the demand for meat is reduced by 7%, while the negative income effect generates an inelastic and negative change in the demand for most of the products with the exception of milk and dairy products and vegetable oils.

In global terms, price interventions seem to have a relatively small effect on quantities consumed as a consequence of the inelastic nature of food demand. Moreover, it can generate adverse effects in food consumption (see also, Schmidhuber, 2004). As an example, Table 8 shows that subsiding fruits and vegetables can marginally curb meat consumption. However, according to economic theory, price interventions have been shown to be effective in generating additional public funds to finance alternative or complementary educational campaigns[8], as also suggested by Nestlé (2002). In fact, an increased of 9% of meat prices generates a 27.54% increase of public funds.

Our final question concerns how the quality of diet is modified after price interventions. The answer is shown in Table 9 for different socioeconomic groups. As demonstrated, the effectiveness of price interventions on the quality of diet is null. In

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[8] In 2005, the Spanish Ministry of health and Consumption has implemented a new policy instrument, named NAOS (Nutrition, physical Activity and ObeSity reduction) specifically addressed to prevent obesity, improve the diet quality and promote physical activities. Several measures have been designed at household, firm, sanitary and educational levels as well as the creation of the Spanish Observatory of Obesity.

fact, under the two scenarios the impact is slightly negative. Among the different clusters, it seems that policy measures are more effective for older people with lower educational levels. In most European countries these are the consumers’ groups towards which health policies are usually addressed. However, as mentioned in Section 6, these are precisely the consumers with a better balanced diet in Spain.

8. Concluding remarks

Nowadays, in developed as well as in an increasing number of developing countries, food diets have become clearly unbalanced having generated a rapid increase of the prevalence of overweight, obesity and related non-communicable diseases. Nutrition policies in the past have concentrated on information and education strategies, which have been proved not to be very effective. Some researchers and heath policy advocates have started to demand more prescriptive measures to improve food diets. One of the most popular proposals to come to grips with the increasing obesity problems and associated economic costs and social externalities has been the implementation of taxes (subsidies) on energy-rich (poor) foodstuffs.

This paper has tried to assess the implications of price interventions on food demand, the quality of the diet and the public budget in Spain. The methodological approach is based on the estimation of a food demand system based on consumers’ maximisation of a utility function, which depends on both food quantities and the level of health reached by consumers, subject to two restrictions: a budget constraint and a health production function. From the estimated price elasticities, the paper simulates the effects of reducing the VAT on healthy foodstuffs (i.e. fruits and vegetables) as well as increasing it on unhealthy ones (i.e. meat).

Results suggest a number of points. The first one is that, although the Spanish diet is clearly unbalanced, it seems that it is of higher quality for rural and lower-education households, just the opposite of what usually is happening in Northern and Central European countries. Rural families are closer to the traditional Mediterranean diet, while wealthier families seem to have been converging, at least to a certain extent, towards energy-rich diets existing in higher income European countries. This fact should take into account when implementing general health policies at the EU level. In any case, we have to note that it is not possible, at least with the data available, to directly relate quality of diet and obesity.

A second interesting result is that, as the Spanish food demand is inelastic, taxes (subsidies) would bring about only a small reduction in demand, thus only providing a small contribution to improving the Quality of Diet of the average consumer and to reduce food intakes and, possibly, obesity. As expected, the impact of the tax (subsidy) declines with the elasticity, while tax revenues increase, thus providing additional public funds to finance educational campaigns or complementary health policies. Although modifying indirect taxes could be considered unfair as they are paid indistinctly by all citizens, it is also true that it has been common practice to obtain additional revenues to finance public policies (i.e. in many Spanish regions, governments have increased gasoline taxes to finance the public health deficit).

In any case, further research is needed in several directions. First, it would be interesting to analyze and compare the results from alternative tax policies, such as taxes on unhealthy nutrients or taxes on excess weight. Second, alternative measures of dietary quality could be explored in the future. Third, there is a need, at least in Spain and other EU countries, to elaborate better databases to carry out deeper studies on the issue investigated in this paper.

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Table 1. Structure of food expenditure in Spain by socio-economic groups (2003)

	Cereals and potatoes	Meat	Dairy	Fruits and vegetables	Fish	Vegetable oils
Average	16,2	24,5	13,8	20,4	13,9	11,3
Town size (inhabitants)						
< 10,000	18,1	24,0	14,2	19,1	12,6	12,0
10,001 - 50,000	17,8	24,1	13,8	20,4	12,6	11,3
50,001 – 500,000	15,3	24,9	13,7	20,1	14,8	11,2
> 500,000	11,5	25,2	12,9	23,8	16,3	10,3
Education level						
Without	19,3	22,6	14,0	20,1	11,8	12,2
Primary school	16,0	24,5	14,1	20,4	13,8	11,2
Secondary school	15,4	25,5	13,3	19,8	15,1	10,9
University	10,6	26,5	13,1	22,4	16,6	10,9
Household type						
1 adult younger than 65	15,6	24,2	11,2	19,8	15,2	14,0
1 adult older than 65	14,8	19,0	14,5	23,9	13,8	14,0
Couple without children	14,7	23,4	12,5	22,1	15,1	12,2
Couple with 1 child	15,4	24,8	14,2	20,0	15,8	9,8
Couple with 2 children	17,5	24,3	15,7	18,7	13,9	10,0
Couple with more than 2 child.	21,9	27,4	17,9	13,9	10,0	8,9
1 Adult with children	16,8	22,1	15,3	19,2	17,9	8,6
Other	16,5	25,5	13,8	19,9	13,3	11,0
Age of the head of the household (years)						
< 25	18,2	27,7	15,1	13,0	16,1	9,9
26 – 45	16,8	25,4	14,3	18,7	14,6	10,2
46 – 65	16,4	25,2	13,4	20,2	13,6	11,2
> 65	15,0	21,9	13,8	22,9	13,5	12,9
Sex Of the head of the household						
Male	16,4	25,0	13,6	20,0	13,9	11,1
Female	15,0	22,5	14,5	21,7	14,0	12,2
Household size (number of persons)						
One	15,0	20,7	13,4	22,6	14,2	14,0
Two	14,5	23,3	12,9	22,1	14,8	12,4
Three	15,5	24,7	13,5	21,2	14,5	10,7
Tour	16,8	26,0	14,0	19,1	13,4	10,7
Five	18,1	26,6	15,4	16,9	12,7	10,2
More than five	20,7	24,5	15,2	18,1	12,0	9,6

Source: Encuesta Continua de Presupuestos Familiares (INE) and own elaboration

Table 2. The prevalence of obesity in Spain

Body Mass Index	Males	Females
< 18,5	0,70	1,73
18,5 – 24,9	41,83	50,50
25 – 26,9	23,38	15,29
27 – 29,9	21,59	16,91
30 – 34,9	12,39	12,71
35 – 39,9	0,70	2,34
> 40	0,30	0,70
Average	25,75	25,51

Source: Aranceta *et al*. (2003)

Table 3. List of potential policy instruments to reduce obesity

Policy instrument	**Objectives**
Measures to change consumer utility function	
Information campaigns	Increase consumers awareness
Advertising regulation	Limit/ban advertising of unhealthy foods (specially targeted to children)
Nutritional education programs in schools	Increase awareness and knowledge of nutritional requirements and health consequences
Measures to allow better-informed decisions without changing the utility function	
Labeling rules	Promote informed choice by signposting healthy and unhealthy nutrients
Nutritional information on menus	Promote informed choice in eating-out situations
Regulating health claims	Define rules and monitor the use of nutrition and health claims in promoting and labeling food products
Funding epidemiological, behavioral and clinic research	Improve knowledge, evaluate policy options
Market measures to change actual choices without changing the utility function	
Tax on unhealthy nutrients / products	Reduce consumption of unhealthy foods
Price subsidy for healthy nutrients / products	Increase consumption of healthy foods
Measures to affect availability	
Regulate liability of food companies	Monetize negative externalities of production/ sale of unhealthy foods
Food standards	Setting nutritional standards for processed food in order to limit the access of unhealthy nutrients
Facilitating access to shopping areas for disadvantaged categories	Address the issue of store dispersion in low-income areas by facilitating access to supermarkets for disadvantaged categories
Fortification and supplementation measures	Improve the nutritional balance of existing foods
Regulate catering in schools, hospitals, etc.	Contrast the tendency of allowing snack vending machines or fast food in public places in exchange for private funding of activities

Source: Mazzocchi and Traill (2005)

Table 4. FAO/WHO/UNU and nutritionist recommendation on per capita nutrient intake

	FAO/WHO/UNU (2004)	Mataix (2002)
Carbohydrates	50-55% of total energy	>40% <70%
Lipids	30-35% of total energy	>20% <45%
Proteins	12-15% of total energy	>10% <20%
Fibre	22-25 gr/day	>10gr/day <40 gr/day
Cholesterol	< 300 mgr/day	< 450 mgr/day

Table 5. The Diet Quality Index and its components by socio-economic groups in Spain

	Carbohydrates	Lipids	Proteins	Fibre	Cholesterol	Index
Average	4.6	5.6	13.0	7.4	16.1	46.7
Town size (inhabitants)						
< 10,000	5.0	5.7	13.1	8.2	14.8	46.8
10,001 - 50,000	5.0	6.0	13.0	8.4	16.0	48.4
50,001 – 500,000	3.7	4.6	13.6	7.7	16.1	45.6
> 500,000	4.1	5.4	11.7	7.7	16.2	45.0
Education level						
Without	5.2	5.7	13.7	9.7	15.0	49.4
Primary school	4.0	4.9	13.2	8.7	14.8	45.7
Secondary school	4.5	5.7	12.6	6.0	17.1	45.9
University	4.1	5.3	11.5	5.6	17.5	44.0
Age of the head of the household (years)						
< 25	3.8	4.9	16.9	3.4	16.8	46.0
26 - 45	5.3	6.6	12.1	5.3	17.8	47.1
46 – 65	4.2	5.0	13.7	8.9	14.8	46.7
> 65	3.7	4.3	13.1	9.8	14.4	45.4
Sex Of the head of the household						
Male	4.5	5.4	13.3	8.0	15.6	46.7
Female	4.3	5.1	12.0	8.0	16.2	45.6
Household type						
1 adult younger than 65	3.5	3.6	12.7	6.8	15.9	42.5
1 adult older than 65	4.3	5.1	11.9	9.6	14.9	45.8
Couple without children	4.1	5.0	12.7	9.5	13.3	44.6
Couple with 1 child	4.7	5.9	12.1	5.2	17.9	45.8
Couple with 2 children	6.4	7.9	11.9	5.2	17.9	49.3
Couple with more than 2 child.	6.2	7.3	14.7	6.6	17.5	52.4
1 Adult with children	7.5	9.3	11.6	4.9	18.6	51.9
Other	4.2	5.0	13.6	8.2	15.9	46.8
Household size (number of persons)						
One	4.0	4.6	12.2	8.6	15.3	44.7
Two	4.2	5.1	12.6	9.3	13.9	45.1
Three	4.0	4.8	13.4	8.3	15.8	46.3
Tour	4.7	5.7	12.9	7.2	16.6	47.1
Five	5.0	6.5	13.8	6.8	16.5	48.7
More than five	5.1	5.1	14.7	6.0	17.3	48.3

Source: Own elaboration from the Encuesta Continua de Presupuestos Familiares (INE)

Table 6. Elasticity of the Diet Quality Index with respect to food expenditure and prices

Food expenditure	-0,229*
Cereals and potatoes prices	-0,113*
Meat prices	-0,038
Dairy products prices	-0,101*
Fruits and vegetables prices	-0,012
Fish prices	0,053
Vegetable Oils prices	0,064*

Table 7. Food demand elasticities

	Cereals and potatoes	Meat	Milk and dairy	Fruits and vegetables	Fish	Vegetable oils
Expenditure	0.974*	1.052*	1.702*	0.993*	0.639*	0.525*
	(21.33)	(23.90)	(33.75)	(20.79)	(10.62)	(8.17)
Uncompensated own price	-0.761*	-0.656*	-1.473*	-0.739*	-0.184*	-0.064
	(-26.30)	(-18.25)	(-34.31)	(-13.38)	(-3.45)	(-0.96)
Diet quality	1.140*	-1.250*	3.715*	-0.046	-1.484*	-1.545*
	(6.01)	(-6.76)	(17.65)	(-0.23)	(-5.89)	(-5.53)

Values in parentheses are t-ratios. 5% significant values are marked with an *

Table 8. Impact of price intervention on quantities consumed and public budget (%)

	Decreasing taxes on fruits and vegetables	Increasing taxes on meat
Cereals and potatoes	-0.06	-0.87
Meat	0.35	-6.94
Milk and dairy products	-0.20	0.83
Fruits and vegetable	2.67	-1.11
Fish	-0.12	-0.02
Vegetable oils	-0.71	0.86
Public budget	-7.83	27.54

Table 9. Impact of price interventions on the quality of diet by socio-economic groups

	Decreasing taxes on fruits and vegetables		Increasing taxes on meat	
	Impact on quantities consumed	Impact on the Diet Quality Index	Impact in quantities consumed	Impact on the Diet Quality Index
AVERAGE	2.67	-1.16	-6.97	-1.20
Town size (inhabitants)				
< 10,000	2.74	-0.52	-6.91	-0.56
10,001 - 50,000	2.57	-1.48	-7.43	-1.55
50,001 - 500,000	2.69	-1.17	-6.76	-1.27
> 500,000	2.60	-0.28	-6.69	-0.32
Education level				
Without	2.64	0.15	-7.24	0.07
Primary school	2.54	-1.18	-6.97	-1.25
Secondary school	2.71	-1.65	-6.89	-1.71
University	3.27	-0.27	-6.09	-0.30
Age of the head of the household (years)				
< 25	3.46	-13.34	-9.39	-13.13
26 - 45	2.98	-1.24	-6.82	-1.31
46 – 65	2.60	-0.66	-6.53	-0.72
> 65	2.36	-0.06	-7.69	-0.15
Sex of the head of the household				
Male	2.70	-0.89	-6.82	-0.92
Female	2.53	-1.31	-7.43	-1.54
Household type				
1 adult younger than 65	3.86	-2.01	-8.38	-1.52
1 adult older than 65	2.21	1.13	-8.24	0.91
Couple without children	2.43	-0.93	-6.92	-0.58
Couple with 1 child	2.93	-2.15	-6.99	-2.03
Couple with 2 children	3.16	-0.56	-7.08	-0.67
Couple with more than 2 chil.	3.53	0.84	-6.71	0.70
1 Adult with children	2.89	1.15	-6.22	0.99
Other	2.59	-1.12	-6.69	-1.33
Household size (number of persons)				
One	2.75	0.58	-8.29	0.55
Two	2.40	-1.10	-7.01	-0.99
Three	2.57	-1.72	-6.76	-1.68
Four	2.83	-0.98	-6.52	-1.26
Five	2.99	-0.77	-7.22	-0.85
More than five	2.60	-1.58	-6.36	-1.80