Distributional Impacts of Fat Taxes and Thin Subsidies[*]

Short Title: **Distributional Impacts of Food Policies**

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Abstract: We conducted an experiment to study the fiscal impacts of unhealthy food taxes and healthy food subsidies on very low and medium income women in France. The policies tend to be regressive and favour the higher income consumers. Unhealthy food taxes increase prices paid more for low than higher income women. Healthy food subsidies reduce the prices paid more for higher than lower income women. The effects arise because the pre-policy diets of the higher income women tend to be healthier but also because the choices of the higher income women are more responsive to price changes.

Given the high prevalence of obesity and the associated medical costs (Cawley and Meyerhoefer, 2012; Finkelstein et al., 2009; Wolf and Colditz, 1998), significant attention has been devoted to designing public policies to reducing weight and health care expenditures. One of the most widely discussed interventions is the "fat tax", which is an umbrella term for a host of policies aimed at altering the relative prices of foods in an effort to encourage healthier eating. Various forms of the fat tax have already been implemented across the world, such as the saturated fat tax in Denmark

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(which was subsequently repealed) and the taxes on sugar sweetened beverages in 40 U.S. States. Some authors have called for an increase in the size and scope of such taxes (e.g., Brownell and Frieden, 2009), and taxes on sugared sodas have recently been implemented in places like Mexico and Berkeley, California. Despite the popularity of fat taxes in many public health circles, there is a great deal of debate about the efficacy and merits of the policies. This paper sheds some light on two of the ongoing debates that relate to the fiscal impacts of such policies.

One of the key issues in the debate relates to the standard economic notion that a price increase almost certainly reduces consumer welfare (e.g., Willig, 1976) absent externalities or other behavioural economic considerations. Moreover, because of Engle's law, which indicates that the poor tend to spend a larger portion of their income on food than the rich, food taxes are regressive. As a result of these concerns, some authors, such as Cash, Sunding, and Zilberman (2005), have suggested "thin subsidies" as an alternative policy to affect weight without adversely affecting the pocketbooks of the poorest in society. However, there is evidence that the non-poor eat healthier than the poor (e.g., Drewnowski, 2009; USDA-CNPP, 2008). As such a "thin subsidy", while not technically being regressive, might have adverse distributional consequences insofar as favoring the rich over the poor, although such inequalities will be driven by the extent to which the poor and non-poor respond to price changes. This study was designed precisely with this question in mind, and we aim to determine the distributional and fiscal effects of fat taxes and thin subsidies on poor relative to non-poor households. Impacts on poor households are of interest because of concerns over equity but also because obesity tends to be correlated with income, at least within some gender and ethnic groups (Chang and Lauderdale, 2005). In France, for example, the prevalence of adult obesity is more than 20% for households with income under €1,500 per month, whereas it is less than 10% for households with monthly income over €3,000.

This paper also contributes to literature that has attempted to project the effects of fat taxes on body weight. A number of studies have used demand estimates and elasticities to simulate the effects of fat taxes (e.g., Brownell et al., 2009; Dharmasena and Capps, 2012; Finkelstein et al., 2010; Kuchler et al., 2005; Okrent and Alston, 2012) and a few have even focused on effects for consumers with different incomes (Smed, Jensen, and Denver, 2007; Tiffin and Salois, 2015). Although there are widely varying results across these studies, they tend to show that small taxes or subsidies are projected to have small effects on body weight, with larger body weight effects being projected by studies which ignore non-linearities in caloric intake and weight change (Hall et al., 2011; Thomas et al., 2013). Other studies have empirically compared pre- and post-health outcomes associated with "real world" taxes and have shown that such taxes have little to no effect on body weight (e.g., Fletcher et al., 2010a,b; Hanks et al., 2013; Powell et al., 2103; 2009; Sturm, 2010).

The divergence in the findings between the two types of studies suggests the need to explore an alternative approach: an economic experiment designed to serve as a middle ground between the simulation-type studies that have a high degree of internal structure and validity (but perhaps miss behavioural realism) and studies that analyse the impact analyses of actual taxes (but which often lack the level of control needed to conclusively identify causal effects).

The primary purpose of this paper is to determine the fiscal impacts of food price policies among people at different points in the income distribution. While the ultimate aim of the price policies is to improve dietary quality and health outcomes, it is much more difficult to determine the ultimate economic impacts of these epidemiological changes, and as such, we primarily focus on the more immediate fiscal impacts of the price policies while acknowledging that there may to be some countervailing economic benefits that arise at some future date. In this paper, we show that fat taxes, thin subsidies, or combinations of the two price policies result in significant changes in dietary choices in our "best shot" environment. However, we find that the policies have divergent effects on poor and non-poor households. Before any tax/subsidy policy, the data reveal that the poor consume nutritionally inferior diets relative to the non-poor. The tax/subsidy policies serve to widen the gap between the poor and non-poor, increasing the inequality in health and fiscal outcomes. Fat taxes cause the poor to pay disproportionally more for food than the non-poor and thin subsidies primarily flow to the non-poor. These effects occur because the non-poor already consume healthier diets but also because the non-poor are more price responsive to than the poor, perhaps because the poor are more habit prone (Chambolle et al., 1999; McAlister and Pessemier, 1982; and Verplanken et al. 2005).

The next section briefly reviews previous research on effects of fat taxes and thin subsidies and outlines our unique contribution. We then describe our experiment and subject pool. The following section conveys the results, and the last section concludes.

1. Background

There are a number of studies that have addressed issues related to those studied in this paper, albeit using different methods and with slightly different focuses.

As previously indicated, a sizable number of studies have used elasticities or demand estimates to project the *ex ante* impact of fat taxes and thin subsidies or have studied the *ex post* effect of taxes on health outcomes, with a heavy emphasis on sweetened sugared beverage taxes, e.g., see Powell et al. (2013) for one review. By and large, these studies have focused on aggregate level outcomes and have ignored distributional impacts. There are, however, a few exceptions.

Finkelstein et al. (2010) utilised scanner data to estimate the effects of a soda tax on consumers in different quartiles of the income distribution. They found that consumers in the lowest income quartile consume a larger share of their daily calories from beverages than higher income consumers and that that consumers in the lowest income quartile have the most inelastic demand for soda. Only middle income consumers were projected to lose a statistically significant amount of weight from the soda tax. The lowest income consumers were projected to pay a smaller share of the overall tax revenue than consumers in the other income categories, in part because they paid lower pre-tax prices for soda than higher income consumers. However, as a percentage of their income, the lower income consumers have a higher tax burden. Finkelstein et al. (2013), Zhen et al. (2014), and Zhen et al. (2011) have subsequently extended some of these results, the latter of which found that beverages are more substitutable for high income households than low income households.

Our study is concerned with more than just a narrow soda or beverage tax. Tiffin and Salois (2015) utilised 2003-2004 data on food expenditures and quantities from the UK government's Expenditure and Food Survey to econometrically estimate food demands and simulate welfare changes from price policies for people at different points in the expenditure distribution. They find that "fat taxes" and a combined tax-subsidy policy are likely to be regressive because those who spend less on food (which they assume to be poor), eat more of the foods targeted by taxes and fewer of the foods targeted by subsidies as opposed to those who spend more on food (assumed to be non-poor). While using a large sample of actual purchase histories, the results rely on a particular econometric model and functional form that assumes identical price responsiveness for all households. Moreover, the effects of a tax/subsidy are simulated rather than observed. Lastly, their findings on policy regressivity relate to different points of the food expenditure distribution, which may or may not correlate well with points on the income distribution.

Other studies have used an experimental approach more similar that employed in this paper to study the impact of fat taxes or thin subsidies (see Epstein et al. (2012) for one review of such papers). These studies have constructed experimental environments to mimic choices in a cafeteria (Giesen et al., 2011; Yang and Chiou, 2010), restaurant (Harnack et al., 2008; Ellison, Lusk, and Davis, 2014), convenience store (Epstein et al, 2006), or supermarket (Ni Mhurchu et al., 2010; Epstein et al., 2007, 2010, 2012). Many of these studies have important drawbacks. For example, many of the studies utilse student subjects, involve only hypothetical choices, only capture choices in a single setting (e.g., convenience store or cafeteria), or do not differentiate among consumers of different income categories. For example, Ellison, Lusk, and Davis (2014) studied calorie labels and calorie taxes and subsidies in a field experiment in a restaurant. While their approach entailed non-hypothetical choices made by people who were unaware they were a part of an experimental design, their field experiment approach was unable to link individual characteristics (such as income) with effects of taxes and subsidies.

Epstein et al. (2010) avoided many of these drawbacks. They constructed a simulated grocery store environment in Buffalo, NY where consumers choice between 34 healthy and 34 unhealthy products. They observed choices in different pricing scenarios where prices of healthy foods were decreased and unhealthy foods were increased. They recruited 20 participants who were identified as lower income (household income of less than $50,000/year) and 22 higher income participants (more than $50,000/year). Epstein et al. (2010) do not find any difference between lower and higher income consumers in terms of the choices made pre- and post-price intervention. They found that taxes and subsidies had an effect on the foods purchased in their experimental environment, with taxes being more effective at changing the nutritional composition of food choices than subsidies.

This paper moves beyond the Epstein et al. (2010) study in several important ways. While their shopping task was non-hypothetical, they required participants to spend the totality of their experimental income ($22.50). One challenge with this design choice is that participants may not act as they would with their own money because their budget constraint was uniformly fixed. Therefore, only substitution effects can be observed. This is potentially problematic for our inquiry because income effects may be important when comparing outcomes across the rich and poor. Furthermore, by forcing a binding budget constraint, the opportunity cost of food nil. Participants cannot save money on food to spend it otherwise. Other commentators, such as Fischer (2014) have noted other incentive problems that can arise when participants are forced to fully spend a fixed budget constraint. Moreover, their low income category is relatively high income compared to that used in this study (as described momentarily, our low income consumers make less than €10,000 per year). In this paper, we focus on fiscal impacts (whereas Epstein et al, 2010 focus on nutritional impacts) of food price policies using a larger sample of lower income consumers faced with a much larger set of food choices.

Our experiment also differs from that used in prior experimental studies in that it asks participants to make an entire day's worth of consumption choices. Therefore, we are able to assess the price intervention on each participant's overall diet. Cafeteria, supermarket, restaurant, and vending machine experiments only reflect a limited part the food consumption during a day. Participants may, for instance, take advantage of a price decrease within the scope of the experiment to buy unhealthy products outside the scope of the experiment. Ignoring substitution effects among food can seriously bias the projected policy impacts (e.g., see results in Finkelstein et al., 2010; Schroeter et al., 2008). We avoid this problem by eliciting an entire day's food choices.

2. Methods

2.1 Overview

In the classification of Harrison and List (2004), we conducted a framed field experiment. The experiment took place in France and focused specifically on female purchasers of food for the household. Participants made choices in an environment in which they selected an entire day's worth of food from a large choice of 180 items offered at various prices. The food selection task was repeated under different pricing policies that either subsidised healthy items or jointly subsidised healthy items and taxed unhealthy items.

The advantage of the experimental set-up is that people's choice behaviours are directly observed (rather than inferred as in a simulation study). In addition, the setting does not require the use of econometric models to infer behavioural responses. There is no need to assume a functional form or structure for responses; each individual can respond in their own unique way according to their own preferences. The experiment attempts to measure the overall fiscal effect (based on a day's food choices) rather than simply focusing on one or two foods or a few food product categories. The experiment environment also allows us to study larger price variations (+/- 30%) than would likely have been feasible outside the lab, and as such, makes the price changes particularly salient.

2.2 Subjects

One-hundred and seven subjects took part in the study. The subjects in our experiment were women between 20 and 52 years old. We focused on women because they remain the primary food shoppers in most households, and because we sought to make our two income groups more homogeneous, at least in the dimension of gender. We specifically recruited low income women through institutions such as health clinics, charity grocery stores, and other charitable organizations. Seventy four low-income women participated in the study. The low-income women had monthly household incomes of €700 or less, placing them in the lowest decile of incomes in France. This is a markedly lower level of income compared to previous studies on the issue that classified low income as those in the lowest quartile or as having annual household incomes of less than $50,000. Portable computers were used to run experiments in private rooms provided by social institutions situated in the poorest suburbs of Grenoble and Lyon.

To determine how the poor behaved relative to the non-poor, we also recruited a reference sample, which consisted of 33 women, whose monthly household incomes were over €1050, thus placing them in at least the third decile of income. Data collection for the reference group took place in the Grenoble Applied Economics Laboratory (GAEL) at the Grenoble Institute of Technology. The difference in recruiting methods for the poor and non-poor households reflects the challenge of recruiting very low-income households, who are often difficult to reach via traditional recruitment means and who can be reluctant to share information with University researchers. We had to recruit the low income women through specialized institutions that they trusted; however, we note that a significant share of our low-income participants learned about the experiment from someone else attending the institutions.

2.3 Experiment

Table 1 shows the basic steps in the experiment. The design permits a within-subject comparison of a day's food choice (what we call a "food day" FD) before and after the implementation of a price policy.

Subjects first completed a questionnaire eliciting socio-economic and demographic information such as occupation, income, and household size. Each subject was then asked to provide an exhaustive description of all the food and drinks that they had consumed over the past 24-hour day (midnight to midnight); a task referred to as Food day 0 (FD0). Data on FD0 was obtained on a declarative basis, that is, without prices or incentives, and the data from this task are not analysed in this paper. The purpose of the FD0 "24-hour reminder" was to familiarize participants with the computer interface and to structure their thoughts on the components of a typical food day. Prior research has shown that such "cognitive design techniques" can improve respondent accuracy (e.g., Jobe and Mingay, 1988).

Each subject then indicated the foods they desired to purchase for the next day, food day 1 (FD1), by selecting from a list of 180 products each with a labelled retail price presented via the computer interface. Once this task was completed, each subject completed a second food day, FD2 (only one food day was randomly selected as binding at the end of the experiment). In FD2, the prices of fruit and vegetables (F&V) were 30% lower than the previous day. Both the old price (crossed out) and the new, reduced price were displayed, increasing the saliency of the price change and ensuring that our approach is likely to provide an upper bound on the effects of the price policy.[1]

In the third phase, each subject was asked to compose a last food day, FD3, which was identical to FD1 and FD2 except the prices of F&V and those of other healthy products were now 30% lower than on FD1 while unhealthy products were priced 30% higher than on FD1. Again, the old prices were crossed out and the new prices displayed next to the old.[2] Finally, subjects filled out a post-experiment questionnaire on their eating habits, height, weight, and health.

We chose to look at a F&V subsidy policy because the French National Institute for Prevention Health Education had undertaken a major campaign to increase F&V consumption and because low income consumers tend to eat fewer F&V as compared to high income consumers (Darmon and Drewnowski, 2008). We were also interested in the effects of a more ambitious policy (enacted in FD3) that was applied to all food rather than a small set of targeted foods and that mixed taxes and subsidies. Several previous studies have showed that taxes on a single nutrient or a single food category can have unintended effects on consumption of other nutrients (e.g., fat) or foods (e.g., sweets), due to substitution or income effects (e.g., Smed et al. 2007; Schroeter et al., 2008). Okrent and Alston (2011), for example, project that only an across-the-board calorie tax would be likely to meaningfully lower caloric intake and reduce body weight.

[1] It is possible that crossing out prices might send information or signal consumers as to an "appropriate" behavior. However, we do not believe that signaling is a major effect in our design. First, we did not explicitly mention the price intervention to participants or tell them how or why prices were changing. The words "tax" or "subsidy" were never used. Second, posting old (crossed out) prices in addition to new prices is a common occurrence in grocery stores, cafeterias, and other retailers, and thus there is some real world parallelism in our design. Third, and perhaps most importantly, in the questionnaire at the end of the experiment, we asked the participants what was, according to them, the aim of the experiment, and in particular we asked why they thought prices changed. Various explanations were offered but surprisingly, only a minority guessed the nutritional objective of the intervention (the most common explanation was to increase profits for supermarkets).

[2] On a €/gram basis, the median price for F&V and other healthy foods were cheaper than unhealthy foods both before and after the price interventions, but on a €/kcal basis, the opposite was true. That the relative price of unhealthy food depends on how it is measured has been noted by others such as Carlson and Frazao (2012).

However, because such taxes can be regressive, we sought to investigate such taxes in conjunction with a healthy food subsidy policy.

Our design might induce a possible order effect, as people first completed FD1 then FD2 and then FD3. Order effects can arise from learning; however, it is unlikely that subjects learned more about the price structure as the experiment proceeded. In our experiment, participants were confronted with the product prices before the baseline began (see table 1). Furthermore, as previously indicated, the price changes were made salient, and as such, little effort was required to identify price changes and subjects did not have to recall past prices. It is possible that the F&V policy in FD2 could have influenced subsequent behaviours in the following nutrient policy in FD3. Bias would appear if participants linked falling F&V prices with the notion that these products are healthy and hence, consume more F&V for that reason. However, the FD3 nutrient policy includes the F&V policy, so that prices of F&V do not change between these two phases. It would have been more problematic if the nutrient policy had been first. Our protocol respects the "increasing information" rule. Moreover, as previously noted (see footnote 1), few participants realized the nutritional objective of the experiment. Finally, note that food shopping is also a repeated task outside the lab. Individuals are confronted with price changes routinely in the supermarket. In this sense, repeating a shopping task is not likely an unusual phenomenon for most consumers.

A subject's primary task during each food day was to indicate all the food, including non-alcoholic drinks, which they intended to consumer over the next 24 hours. Using dedicated software, participants composed their meals by picking products from a tree-structured database. Once a product had been selected, the subject chose the desired quantity by means of visual aids and quantitative information on volume and weight. Thus, each subject could finely calibrate each of their food portions. A screen-shot of one of the input screens is presented in Appendix A.

The decision making context in a given food day involved participants choosing all the items that were to be eaten in a day (as opposed to a single meal or as opposed to a supermarket setting involving prepackaged foods). Thus our food day describes "what goes into the mouth" as opposed to "what goes in the cart". We chose this context for several reasons. It allows us to more closely link individual choices with individual health outcomes. We wanted to avoid situations where the mother selected food for all family members, confounding preferences of the individual with preferences of the rest of the family, the number of individuals in the family, etc. This approach also allows us to side-step issues associated with cooking and (unobserved) added ingredients. Finally, we wanted to avoid brand effects. For instance, we wanted to avoid cases, for example, where a participant did not buy breakfast cereal in our experiment, not because she did not like cereals but because she did not find her favourite brand.

Subjects could select between 180 different products, carefully chosen on the basis of average consumption by French people (the products are listed in Appendix B) and in consultation with prominent nutritionists. In many respects, 180 options is a large amount that permits a diverse range of food behaviours, much more, for example, than in Epstein et al. (2010). Many of the previous studies that have analysed the effects of fat-taxes and thin-subsidies have done so using econometric estimates and simulation. These approaches typically aggregate all foods into a small number of categories (typically less than 10), and investigate how taxes/subsidies cause substitutions across these few categories. Seen in this light, our approach allows for many, many more substitution possibilities than does the typical paper in this genre, which imposes a very limited degree of substitution – typically assuming a particular constant elasticity form.

In other respects, however, 180 options is a small subset of the tens of thousands of products sold by supermarkets. Nevertheless, many of the options offered by supermarkets are superfluous in relation to our objectives because they entail very close substitutes, brands, package sizes, etc. In our study, we only deal with generic and ready-to-use food items. For instance, while laboratory participants could pick chocolate breakfast cereal, the everyday shopper is facing an entire shelf display of breakfast cereals. In our study, we did not need such differentiation, as the fiscal policies we tested did not differentiate between such close substitutes. That is, the price policies we model are such that they are unlikely to cause much within-category substitution (since all products within a category have prices that move in the same direction); it is the cross-category substitution patterns that are likely most important given our price polices, and these broad categories are well represented in our choice of 180 products.

To be clear, participants were asked to construct a future food day by planning what they were going to eat *at home* (not at restaurants) for the next 24 hours from a pre-determined list of food items. Some of these items were raw ingredients (like oil, garlic, fresh cream, vegetables, etc.) and some items were ready-to-consume items (like pizza with meat, ready-made vegetable soup, etc.). Thus, participants could either pick ready-made dishes or consider cooking recipes like they would using items bought from a grocery store. If a participant was willing, for instance, to make her own salad (rather than the pre-made tomato/cucumber salad available in the list), she could pick raw ingredient from the list to make her own salad (for instance, a participant might pick avocado, green salad, tuna, oil, fresh cream, and salt). Importantly, participants had to pick the exact quantity of each ingredient necessary to make her salad. The experimenters did not perform any actual cooking – rather we sold participants the ingredients they would use in their own kitchen to make the described dishes. If participants picked raw ingredients like salad, avocado, or tuna, they really bought (when binding) fresh salad, loose avocado, or a small tuna box (always according to the quantity requested). If participants picked ready-made dishes like vegetable soup or meat pizza, they bought (when binding) a vegetable soup pot and a pizza box. If a participant picked raw ingredients such as pasta and tomato sauce in order to make spaghetti, we would sell her dry pasta and a jar of tomato sauce (or loose tomatoes and onions if the participant opts to make the sauce by herself; she would thus pick raw tomatoes and onions rather than a ready-made tomato sauce). For logistic reasons, all food items were not binding (and thus not available though, crucially, the participants didn't know which items would actually be binding and which would not when choosing).

For each of the 180 products product, a price was displayed for a reference quantity and it was scaled, at a linear rate, for the portion chosen by the subject. The software showed images of each of the dishes (see appendix A for an example), and it calculated and displayed the running total expenditures in the given food day, updated continuously as new products were selected. Prices in FD1 correspond to retail prices at the time of the experiment in the largest French food cybermarket, Ooshop, a subsidiary of the Carrefour group. The participants were informed of this source of retail prices.

The categorization of healthy and unhealthy products used in our pricing policies is based on the SAIN, LIM classification (Darmon et al., 2009). SAIN is an index of "good" nutrients that should be consumed in higher quantity to comply with national nutritional recommendations, and LIM is an index of "bad" nutrients to limit. The indices are based on quantities of nutrients compared to the recommended nutritional intake. In simple terms, these indexes are a weighted average of the density of respectively good (vitamins, fibers, calcium, etc.) and bad (SFA, sugar, salt) nutrients contained in each food product. Therefore, heavier (in grams) 'unhealthy' food products contain larger quantities of bad nutrients. In FD3, subsidised products had a high SAIN and a low LIM. By contrast, the taxed products had a low SAIN and a high LIM.[3] The products that belong to neither of these categories are referred to as "other products" (OP), and they were neither taxed nor subsidised. The food products falling in each category are shown in appendix B.

As previously indicated, the price policies were implemented implicitly, that is, without calling them "taxes" or "subsidies" and without mention of their relation to nutritional composition. Otherwise, the experiment would be a test of *both* a price policy and an information policy.

2.4 Monetary Incentives

Each participant received a €25 show-up fee.[4] For FD1, FD2 and FD3, the subjects were informed that their choices would generate real sales at the end of the experiment. Subjects were informed that one food day would be randomly selected as binding. Moreover, they were informed that a subset of the 180 products had been pre-selected and were placed in a room adjacent to the experiment. If a subject chose one of the pre-

[3] Following Darmon et al. (2009), the thresholds were set at 5 for SAIN and at 7.5 for LIM.

[4] Providing a monetary endowment might influence people's choices. However, without compensating participants for the opportunity cost of time, recruitment would have been much more difficult and the subject pool less representative. We made several efforts to reduce the "found money" effect. First, we gave the participants the money at the onset of the experiment before the start of the instructions. We made it clear that the money remunerated the time spent with us and was not an experimental endowment, and we emphasized that the money could be taken home. Second, as we indicated in the background section, the endowment would have been more problematic had subjects been required to spend the total amount in the experimental session. That is, we did not fix a lower/upper spending limit. Thus, opportunity costs were not inhibited: the money saved in the lab could be used outside the lab and the money spent in the lab is lost outside the lab. That way, experimental money does not become "monopoly" money.

selected products in the randomly selected food day, they purchased the product in the quantity and at the price corresponding to their selection during the experiment. Thus, at the end of the experiment, each subject actually purchased the exact quantity of all food items that (i) had been selected during the experiment in the randomly selected food day and (ii) were available in the lab (around 50 items).

While the random selection of binding products might not perfectly parallel the real world, it does create an economic environment that induces subjects to careful consider their choices. Participants knew from the beginning that they would have to purchase some of the food products they chose during the experiment. The incentive scheme is incentive compatible (it gives subjects an incentive to truthfully reveal their preferences) and it is convenient. First, by choosing a product they dislike, participants risk of bringing home an undesirable product and paying a price that is more than it is worth to them. Second, if consumers do not select products for which the price is less than their value, they give up potential consumer surplus. Finally, we allow opportunity costs outside the lab by not fixing the budget. Thus, participants have to seriously consider how they spent money in the laboratory environment.

2.5 Data Analysis

To calculate the fiscal impacts of the price policies, we calculate Laspeyres and Paache price indices. The Laspeyres index calculates the change in prices paid relative to the initial pattern of consumption; the Paasche index is similar except that it weights prices paid using the new pattern of consumption.

The advantage of the Laspeyres and Paasche indices is that they have intuitive interpretations and can be readily calculated using our data. When used individually, each index only provides a crude indication of changes in consumer welfare. However, when used together, they can help bound the welfare impacts. As shown by Hicks (1942), in the case of a price decrease, the Laspeyres index underestimates compensated variation (how much is required to compensate for the effect of a price change) and the Paasche index overestimates equivalent variation (how much income would have to be taken away from an individual, at the base price level, to have the same impact on their utility as the price change). For a price increase, the reverse is true. One popular approximation to the welfare effects of a price change introduced by Harberger (1971) is the average of the Laspeyres and Paasche quantity variations.

Laspeyres and Paasche indices are based on (different) fixed baskets. Consequently, they do not yield information on substitution effects when they are considered separately. However, the comparison of indices sheds light on consumers' substitutions. For instance, a lower Paasche index relative to the Laspeyres index means that consumers have been compliant with the policy by substituting non-subsidised products with subsidised products. By using both the Laspeyres and Paasche indices together in one study, we can determine the extent to which the impacts of price policies are a result of initial consumption patterns or consumers' willingness to substitute toward subsidised or non-taxed items.[5]

The Laspeyres and Paasche indices only require minimal information: price and quantity purchased in the reference situation and price and quantity purchased in the reform situation. By observing food consumption before and after the price policy, the experimental data provide all the necessary information for calculation of the indices

[5] More accurate welfare assessments could be derived using second order approximations such as those suggested by Banks et al. (1996) (note: the first-order approximation of Banks et al. (1996) is equivalent to the Laspeyres variation; we use this calculation in index form and couple it with the Paasche index). However, the derivation provided in Banks et al. (1996) requires the own- and cross-price elasticities of demand for each of the 180 goods (each of which are not uniquely identified in our design) for each person, and would ignore data on post-intervention purchases. While it might be possible to construct a second-order welfare measure analogous to that used by Banks et al. (1996) which makes use the post-intervention data, we leave this issue for future research and continue with the use of the Laspeyres and Paasche indices, which have intuitive interpretations and are well suited to the kind of data generated by our experiment.

without extra assumptions or approximations (demand function, utility function, etc.). The extent of the fiscal burden of a price policy is dependent upon the food baskets of each individual. Both indices can be calculated at the individual level. Therefore, they allow for a direct comparison of different consumer types (e.g., poor and non-poor) and highlight the dispersion of behaviours.

3. Results

Table 2 shows the mean consumption patterns for consumers in each income group under each pricing policy (the appendix contains additional results and statistical significance tests). First, we note that the average amount spent by each participant, around €5, was remarkably close to the average expenditure for food at home in France, which was €5.80 per person per day at the time of the experiment (Caillavet et al., 2009). Not surprisingly, respondents in the low income group chose a lower total volume of food and had lower average expenditures than the reference, non-poor group (-339g, p=0.083).

Looking first at food day 1, the results support the hypothesis that low income women tend to eat less healthy than women in the higher income category. Low income women purchased fewer other healthy products (519 vs. 704g, p<0.001) than the non-poor. The poor purchased more unhealthy products (323 vs. 196g; p=0.123) and fewer F&V (410 vs. 515g, p=0.152) than the non-poor. Unhealthy food factors even more prominently in the diets of the poor when one looks a differences in the share of total consumption (+7.8%, p=0.056) or as a budget share (+14.5%, p=0.029).

As expected, the first price policy, a 30% reduction in the price of F&V, increased consumption of F&V for people in both income categories. However, the non-poor were more responsive to the price reduction than the poor. F&V purchased increased 24.9%

(p=0.047) for the poor and 38.3% ($p<0.001$) for the non-poor, implying category own-price elasticities of -0.83 and -1.28, respectively. The change in F&V purchases significantly differed for the poor and the non-poor (p=0.010). The results suggest that while the F&V subsidy increased F&V consumption for the poor, the effects on the non-poor were even greater.

Food day 3 enacted an entire nutrient profile price policy by combining a healthy food subsidy and unhealthy food tax. Relative to food day 1, the low income group increased consumption of F&V from 410 to 516g (a 25.8% increase; p=0.006) but there was no significant change in the consumption of unhealthy food (mean fell from 323g to 246g, a 23.8% reduction; p=0.197). The change in consumption of other healthy food was not statistically different from zero for the low income consumers (mean fell from 519 to 493g, a 5% reduction; p=0.677). Relative to the low-income group, the non-poor reference group experienced a similar percentage increase in consumption of F&V (a 24.9% increase; p=0.015), but they increased consumption of other healthy foods by 18.8% (p=0.008) and reduced consumption of unhealthy food by an even greater amount (-35.2%; p=0.034) than the non-poor. Again, the results suggest more that the policies induced more pronounced behavioural responses from the non-poor relative to the poor.

Table 2 reports the mean responses for consumers within an income category, but the means mask a great deal of heterogeneity. Heterogeneity that is a direct result (and benefit) of our experimental setting what allows for a wide diversity of behaviours. Figure 1 illustrates the budget shares allocated to healthy vs. unhealthy food prior to the enactment of the price policies. No participant in the reference income group allocated less than 20% of their budget to healthy food, but more than 13% of low-income respondents exhibited such behaviour. Best fitting polynomial curves fit to the data illustrate the propensity for lower-income women to allocate a greater share of their food budget to unhealthy food.

There was also substantial heterogeneity in how participants responded to the policies. Figure 2 shows the difference in the budget share allocated to healthy vs. unhealthy food in food day 3 relative to food day 1. The figure reveals that, on average, the nutrient price policy increased the budget share for healthy food for the non-poor but the reverse happened for the poor. Indeed, a non-trivial number of respondents in the low income group (39% of the total) behaved in a manner opposite the intention of the policy. They allocated a larger share of their budget toward unhealthy food and a smaller share toward healthy food after the nutrient price policy (note: the two categories do not have to sum to one because of the "other food" category). This result might stem from a lack of price-responsiveness. If the consumption bundle remains unchanged after the nutrient price policy, then by definition, expenditures on unhealthy food will rise and expenditures on healthy food will fall.

The preceding results provide some insights into the distributional consequences of the food price policies, but deeper insights are available in table 3. Table 3 reports the mean subsidy and tax that would be expected to be received or paid based on the initial pattern of consumption in day 1 or based on the new pattern of consumption revealed in food days 2 or 3. Evaluated at initial consumption levels, the subsidies paid by F&V policy are larger for non-poor than the poor (€0.47 vs. €0.35, p=0.078). The combined nutrient policy provides a subsidy of €0.70 to low income consumers but a higher €0.95 subsidy to non-poor consumers. Moreover, the poor pay higher taxes than the non-poor (€0.47 vs. €0.28; p=0.179) under the combined nutrient price policy. As a result, the expected cost of eating falls by only 4.7% for the poor but by 12.1% for the non-poor according to the Laspeyres price index. These results arise solely from the fact that the initial dietary pattern of the low-income women is less healthy than that of the reference income group.

Evaluated at final consumption levels, the low income consumers effectively received €0.42 on average from the F&V subsidies. With the combined nutrient policy, the low income consumers receive subsidies of €0.77 and pay taxes of €0.37, on average. The mean subsidy received by the reference income group is €0.66 with the F&V policy and €1.39 with the nutrient policy. They also pay €0.11 in taxes. While consumers in both income groups experience lower the cost of eating, the price policies tend to favor the non-poor more than the poor. The effective cost of eating for the low income group fell by 8.8% with the F&V policy and by 8.6% with the combined nutrient policy; however, the cost of eating for the higher income group fell by 11.5% and 21.9% under the two policies according to the Paasche index (the differences between groups are significant at the p=0.013 and p=0.020 levels for the two policies).

Comparing the Paasche index to the Laspeyres index provides an indication of how consumers' price responsiveness affects the cost of eating because the Paasche index evaluates the price policies at the new, updated consumption levels. For the combined subsidy/tax policy, the price index for the low-income group only falls from 95.3 (Laspeyres) to 91.4 (Paasche). Thus, for the low-income group, the cost of eating is 8.6% lower based on the updated consumption pattern. However, for the non-poor, the price index falls from 87.9 (Laspeyres) to 78.1 (Paasche); a differences that is statistically significant at the p=0.010 level. The larger change for the non-poor suggests much greater responsiveness to the price policy, and the combined nutrient policy reduced the cost of eating by 21.9% according to the Paasche index. These results highlight the fact that the non-poor were much more responsive to the price policies than were the poor, and as a result, the budgetary effects benefited the non-poor to a much greater extent than the non-poor (not counting the government expenditures, which, of course, must ultimately be paid by someone).

Figure 3 shows the distribution of fiscal impacts for the combined -30% F&V, -30% Health Food, +30% Unhealthy Food policy for the low income and reference income samples (note: because the policy increases the prices of one category of food by 30% and reduces prices in two categories by 30%, the minimum and maximum values for the indices are 70 and 130, corresponding to individuals who only purchased foods in one of the affected categories). Based on the Laspeyres index, 31.5% of low income respondents faced a higher cost of food as a result of the price policy. Even after consumption adjustment, the Paasche index reveals about 25% of low income women faced a higher cost of food. The nearness of the lines showing the Paasche and Laspeyres indices for the low income group again re-enforces the relative lack of responsiveness of the poorer respondents to the pricing policy. The Paasche index is higher than the Laspeyres index for 35.9% of low income individuals. These individuals did not shift their diet in the intended direction.

In stark contrast to the low income participants, those in the reference group category stood more likely to fiscally benefit from the price policy (according to the Laspeyres index), and they responded in a manner that lowered the cost of food (according to the Paasche index). Indeed, only 17.9% of the non-poor consumers would have increased their cost of eating with no change in their diet as compared to 31.5% for the poor (p=0.060). Evaluated at post policy consumption, every respondent in the non-poor category faced a lower cost of food as compared to only 23.9% of the poor consumers (p=0.004). The much wider distance between the Laspeyres and Paasche indices for the non-poor indicates greater responsiveness to the price policy, and the distribution function of the Paasche index for the reference income group never intersects that for the low-income group. At the median, the Paasche index for the non-poor was about 78, but it was only about 87 for the poor. Finally, Paasche index is higher than the Laspeyres index (signalling a move away from a diet intended by the policy) for only 15.2% of the non-poor but the same is true for 35.9% of the poor respondents (a difference that is statistically significant at the p=0.029 level).

4. Discussion and Conclusions

How do the price policies differentially affect women at different points in the income distribution? Beliefs about the relative effects of fat taxes and thin subsidies on the poor relative to the non-poor are often premised on two assumptions. First is the assumption that the poor consume less healthful diets than the non-poor, perhaps due to the higher costs of more healthy diets (e.g., Drewnowski and Specter, 2004). The second assumption is that price policies are more likely to benefit low income consumers because low income consumers have more room for improvement, and because of their financial situation, they are likely to be more responsive to price changes. In short, a common view is that price policies can help the poor "catch up" to the non-poor in terms of the healthfulness of their diets.

Our experimental results confirm the first assumption: poor women tended to purchase less healthy food than the non-poor women. The implication is that, holding initial consumption patterns constant, policies which tax unhealthy food and subsidise healthy food will be regressive, favouring the non-poor more than the poor. But, people can change consumption patterns in response to price policies. If the poor are more responsive to price policies than are the non-poor, then inequalities will be dampened. This hypothesis, however, was rejected. Behavioural adjustments to the price policies amplified rather than dampened the divergent fiscal impacts of the price policies.

Despite these results, it could be argued that a policy is justified if the healthfulness of low income women's diets improves as a result of food subsidies or taxes. Moreover, price regressivity does not necessarily imply health regressivity. If the poor are more likely to suffer from obesity and diabetes than the non-poor, then price policies may help the poor "catch up" in terms of their body weight and will result in progressive health effects. The results of our experiment suggest that fruit and vegetable subsidies (or combined healthy food subsidies/unhealthy food taxes) do seem, for the most part, to shift the diets of poor women in the intended direction. The subsidy-alone policy produced similar nutritional changes in the meals selected by poor and non-poor consumers. However, the combined subsidy/tax scheme resulted in more positive nutritional changes for the non-poor than the poor, further widening the potential health disparities between the two income groups. This study makes no attempt to determine whether the benefits of these dietary changes would exceed the deadweight loss and administrative costs of the policy.

The experiment has some drawbacks that likely limit the extent to which the findings can be extrapolated to real price policies. We utilised a within-subject design in which choices for a "base" day were followed by choices under a particular pricing policy. Although subjects were not told how or why prices were changing, the magnitudes of the change, coupled with the within-subject design, are likely to lead to an upper-bound estimate of the potential policy impacts. Moreover, the pricing policies were based on a particular characterization of a food's healthiness based on the SAIN/LIM system utilised by the French Food Standard Agency (see also Darmon et al., 2009), which may yield results that differ from pricing policies based on other classification systems. Moreover, behaviour in our "one shot" laboratory environment may or may not reflect how people respond in the context of daily life, as habits may, over time, draw people back to a set of purchases after a particular price change.

Despite these drawbacks, our design allows for a direct comparison of the fiscal effects of fat taxes and thin subsidies on the poor and non-poor. Whatever health benefits these policies might create, this paper suggests they need to be weighed against the adverse monetary effects they have on some of the poorest people in society.

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Additional Supporting Information may be found in the online version of this article:

Appendix A. Screen Shot of User Interface.

Appendix B. Categorization of Food Products.

Appendix C. Statistical Test Related to Table 2.

Appendix D. Statistical Test Related to Table 3.

Appendix E. Effects of Price Policies on Nutritional Content of Meal Choices.

Data S1.

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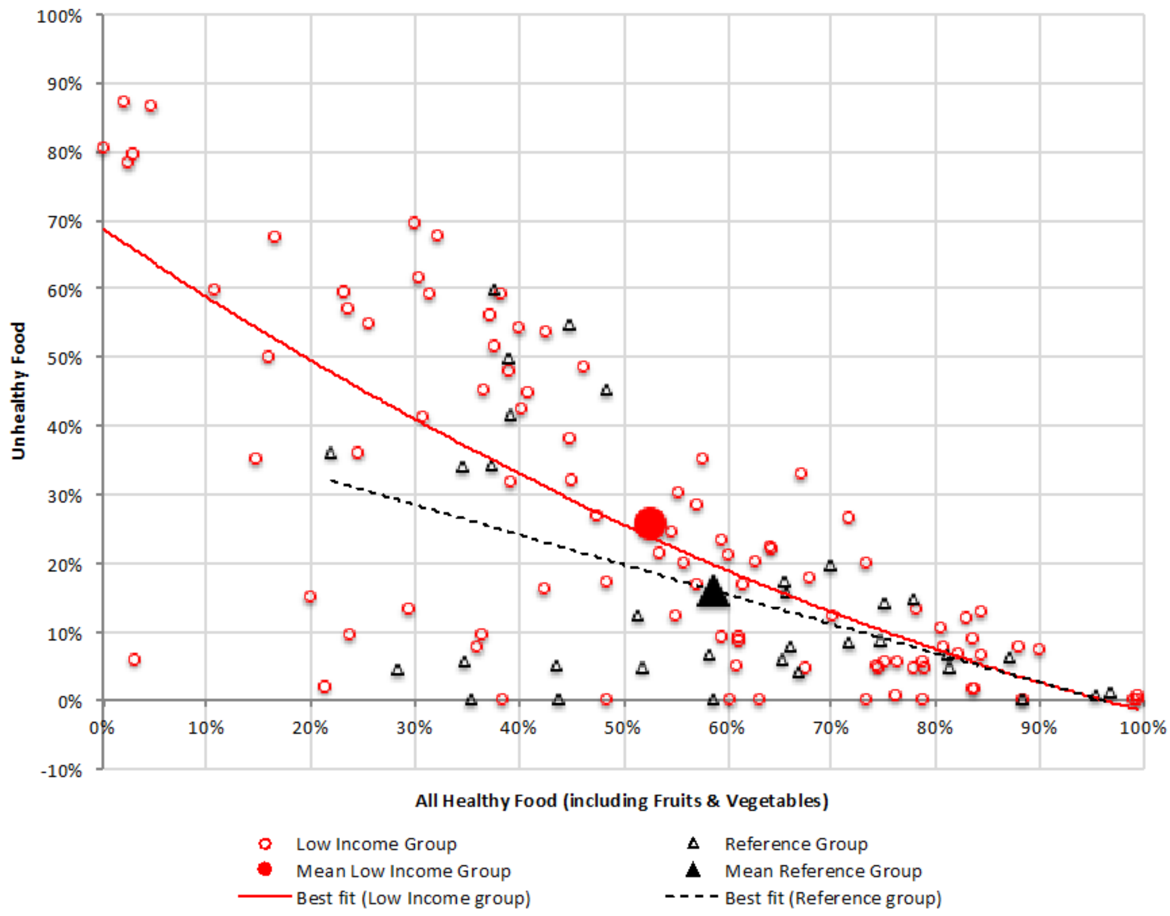


Fig. 1. *Budget share allocated to healthy vs. unhealthy food in food day 1*

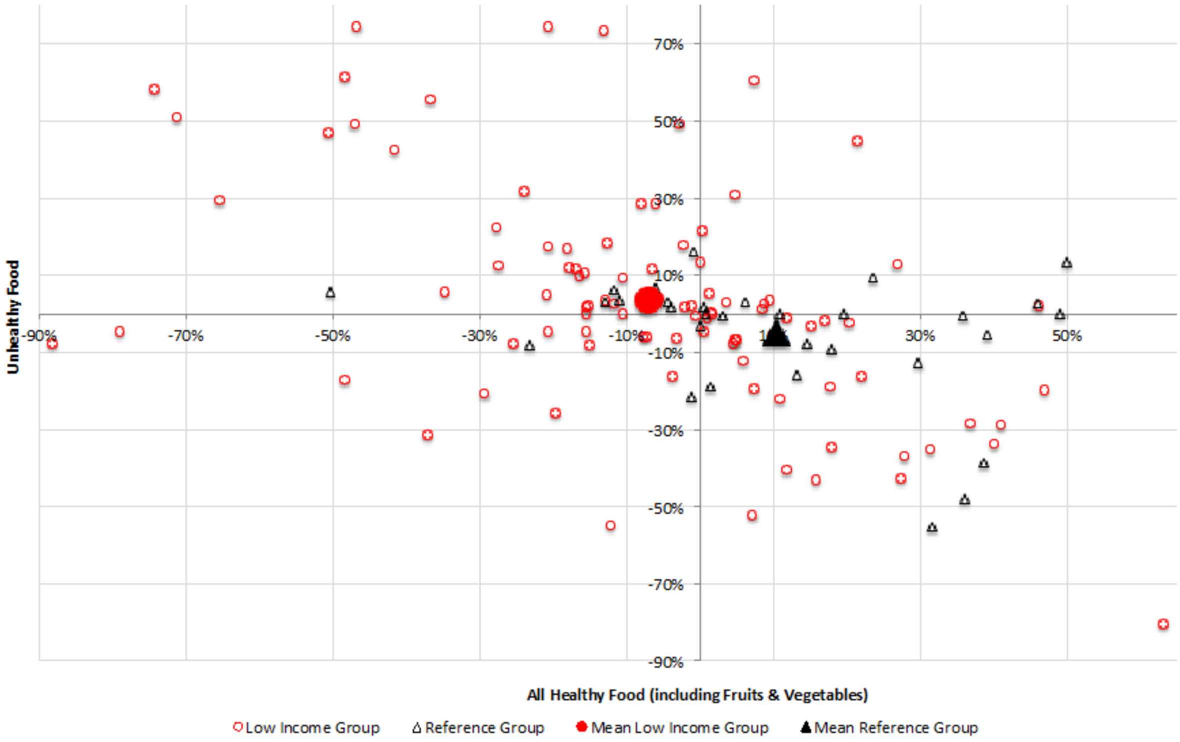


Fig. 2. *Change in budget share allocated to healthy vs. unhealthy food resulting from nutrient price policy (difference in budget share between food day 3 and food day 1)*

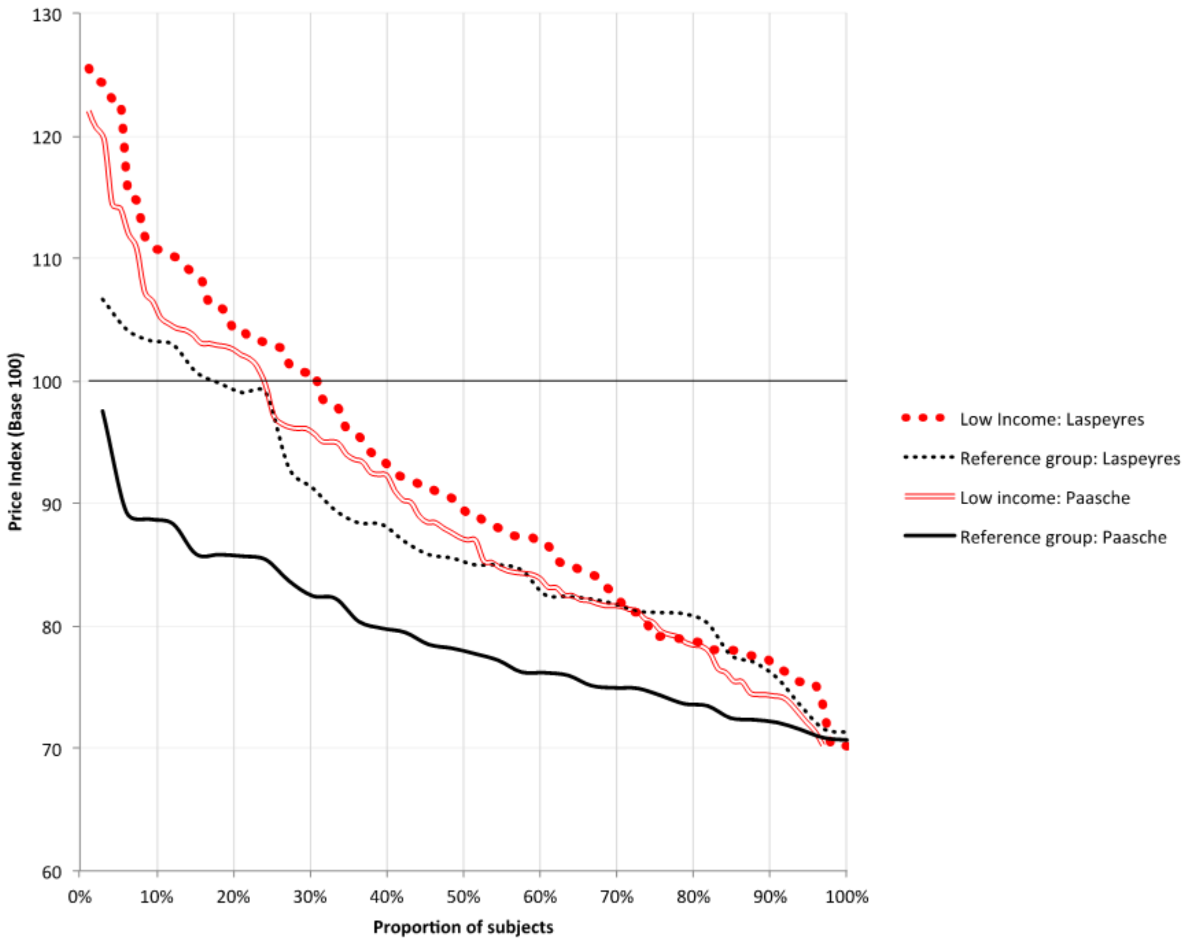


Fig. 3. *Distribution of the price indices for the combined tax/subsidy price policy for low-income and reference-income groups*

Table 1

Steps in the Experiment

Steps	Survey 1	Food day 0	Food day 1	Food day 2	Food day 3	Survey 2
Contents	Socio-demographic	Past 24-hour day	Next 24-hour day	Next 24-hour day	Next 24-hour day	Eating habits, height, weight, and health
Price conditions		ignoring prices	market prices	-30% F&V	-30% F&V -30% healthy +30% unhealthy	
Modality	Declarative	Declarative	With incentives	With incentives	With incentives	Declarative

Table 2

Mean Volume of Purchase by Food Category, Income Group, and Price Policy

Volume (grams)	**Low income group (LIG)**			**Reference group (RG)**			**LIG-RG**	**ΔLIG-ΔRG**	
	Food Day 1[a]	Food Day 2[b]	Food Day 3[c]	Food Day 1	Food Day 2	Food Day 3	Food Day 1	Food Day 2	Food Day 3
Fruits & Vegetables (F&V)	410	**512** *0.047*	**516** *0.006*	515	**712** *<0.001*	**643** *0.015*	-105 *0.152*	**-95** *0.010*	-22 *0.585*
Other healthy food (OHP)	519	514 *0.990*	493 *0.677*	704	737 *0.993*	**836** *0.008*	**-185** *0.001*	-38 *0.887*	**-158** *0.034*
Unhealthy food (UHP)	323	309 *0.487*	246 *0.197*	196	191 *0.936*	**127** *0.034*	+127 *0.123*	-9 *0.556*	-8 *0.491*
Other food	727	670 *0.226*	654 *0.536*	903	**831** *0.047*	810 *0.205*	-176 *0.254*	+15 *0.419*	+20 *0.470*
Total	1979	2005 *0.492*	1909 *0.788*	2318	2471 *0.124*	**2416** *0.082*	**-339** *0.083*	-127 *0.291*	-168 *0.166*
Expenditures (€)	**Low income group (LIG)**			**Reference group (RG)**			**LIG-RG**	**ΔLIG-ΔRG**	
	Food Day 1[a]	Food Day 2[b]	Food Day 3[c]	Food Day 1	Food Day 2	Food Day 3	Food Day 1	Food Day 2	Food Day 3
Fruits & Vegetables (F&V)	1.17	**0.98** *0.043*	1.04 *0.131*	1.57	1.55 *0.629*	1.75 *0.915*	**-0.40** *0.078*	-0.16 *0.131*	-0.31 *0.402*
Other healthy food (OHP)	1.17	0.99 *0.507*	**0.76** *0.001*	1.60	1.54 *0.707*	1.48 *0.573*	**-0.43** *0.012*	-0.12 *0.524*	-0.29 *0.251*
Unhealthy food (UHP)	1.57	1.41 *0.387*	1.58 *0.802*	0.94	1.14 *0.616*	0.46 *0.201*	+0.63 *0.179*	-0.36 *0.322*	+0.49 *0.206*
Other food	0.98	0.98 *0.892*	0.92 *0.720*	1.41	**0.89** *0.054*	**0.81** *0.022*	-0.43 *0.167*	+0.52 *0.121*	**+0.54** *0.090*
Total	4.88	**4.37** *0.047*	**4.30** *0.025*	5.51	**5.11** *0.040*	**4.57** *0.015*	**-0.63** *0.081*	-0.11 *0.697*	+0.36 *0.224*

[a]Choices at prevailing market prices
[b]Choices with a 30% reduction in the prices of fruits and vegetables
[c]Choices with a 30% reduction in the prices of fruits and vegetables, a 30% reduction in the prices of other healthy food, and a 30% increase in the price of unhealthy food
Note: p-values are in italics, significant means are bolded. In the lower income group (LIG) and reference group (RG) columns, p-value relate to the null hypothesis of no difference from food day 1 (Wilcoxon signed-rank), in the comparison columns, p-value relate to the null hypothesis of no difference between groups (Wilcoxon sum rank test); in the food day 2 ad 3 columns, the p-values relate to the null hypothesis of no difference from FD1. Other tests of statistical significance related to policy and income group effects are in appendix C.

Table 3

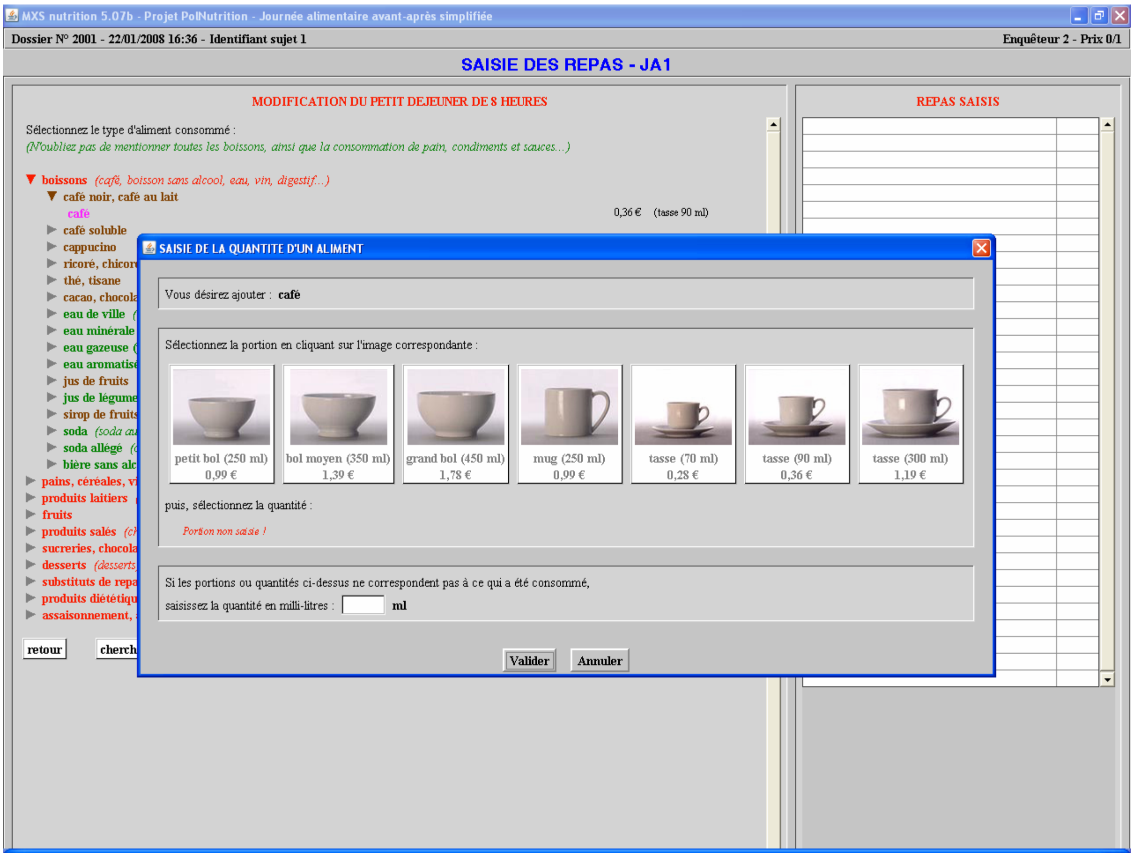
Mean Subsidies, Taxes, and Price Indices by income category and price policy

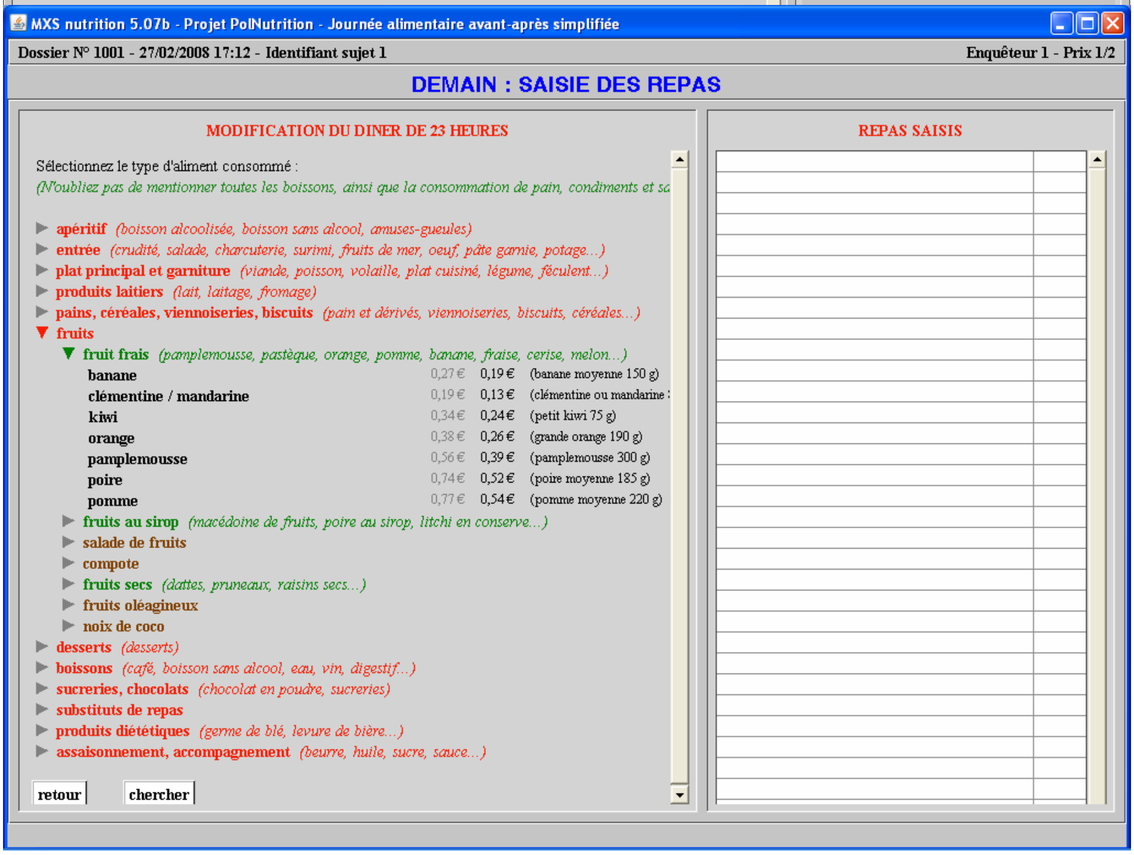
		Evaluated at Initial Pattern of Consumption (Food day 1)		Evaluated at New Patterns of Consumption (Food days 2 and 3)	
		-30% Fruits & Vegetables	-30% F&V and Healthy Food +30% Unhealthy Food	-30% Fruits & Vegetables	-30% F&V and Healthy Food +30% Unhealthy Food
Low Income group	Mean Subsidies	€0.35	€0.70	€0.42	€0.77
	Mean Taxes	-	€0.47	-	€0.37
	Price Indices (base 100)	92.8 (Laspeyres)	95.3 (Laspeyres)	91.2 (Paasche)	91.4 (Paasche)
Reference group	Mean Subsidies	€0.47	€0.95	€0.66	€1.39
	Mean Taxes	-	€0.28	-	€0.11
	Price Indices (base 100)	91.5 (Laspeyres)	87.9 (Laspeyres)	88.5 (Paasche)	78.1 (Paasche)

Note: Tests of statistical significance related to policy and income group effects are in appendix D.

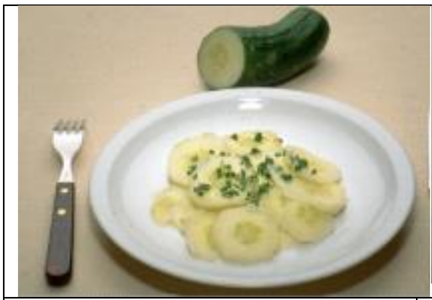
Appendix A

Screen Shot of User Interface





Examples of dishes offered

		
Cucumber	Pasta	Lamb chop/grilled mutton

Appendix B

Categorization of Food Products

- The Fruits and Vegetables:

The Fruits: avocado - banana - lemon - clementine/mandarin - dried prickly pear - orange juice - kiwi - orange - grapefruit - pear - fruit salad - apple
The Vegetables: garlic - vegetable mix for soup - eggplant - carrot - grated carrot - cooked white cabbage - cauliflower - cucumber - zucchini - spinach - haricot bean - flageolet - string beans - frozen string beans - *jardinière* - lentils - *macedoine* (mix of vegetables) - onions - peas - chick peas - pepper - steamed potatoes - mashed potatoes - ratatouille - tomato and cucumber salad - green salad - vegetable soup - ready-made vegetable soup - *tabbouleh* - tomato

- The Other Healthy Products:

slim cereal bar - grilled beef steak - cod - coffee - hake - prawns - roasted chicken leg - *fromage frais* 20% fat content - semi-skimmed milk UHT - skimmed milk UHT - whole milk UHT - rabbit - coalfish - roasted duck fillet - whiting - mussel – hard-boiled egg - diet Orangina – whole-wheat bread - pepper - fish soup - tea - tinned tuna - brown trout - plain yoghurt with bifidus - plain yoghurt

- The Neutral Products:

Camembert cheese - chocolate cereal - sweetened cereal - chewing gum - sweetened chocolate powder – diet coca-cola - sweetened stewed apple - coq au vin - plain cornflakes - chocolate cream dessert - dried dates - tap water - mineral water - sparkling water - sweetener - Emmenthal cheese - grated cheese - oil - groundnut oil - raw ham - boiled ham - apple juice - grape juice - ketchup - lasagne - sweet corn - mustard - hazelnuts - walnuts – omelet - farmhouse loaf - meat *paté* - pastry - frozen small potato cakes - raisins – Reblochon cheese - white rice – Roquefort cheese - potato salad - ham and cheese sandwich - sardines in oil - tomato sauce - smoked salmon - salt - steak mince - herbal tea - salad dressing - fruit yoghurt

- The Unhealthy Products:

fresh cream - sweetened pancakes - croissant - toasted cheese and ham sandwich - éclair - caramel custard – non-salted crisps - goat cheese - soft cheese - processed cheese - exotic dried fruit and seeds - ice cream - sliced potatoes baked with milk - cottage pie - hamburger - hot dog with mustard - *madeleine* - margarine - mayonnaise - chocolate mousse - apricot nectar - salted cashew - black olive - Orangina - chocolate-filled pastry - lamb chop/grilled mutton - mutton couscous - sweet roll - sandwich loaf - chocolate spread – salted pistachio nuts - pizza with cheese, meat and vegetables - breaded fish - salted crisps - pound cake - pike quenelle - quenelle in sauce - quiche lorraine - ravioli with meat and tomato sauce - roast pork - kebab sandwich - frankfurter - salami-type sausage - fruit cordial - sorbet - sugar - fruit pie - leek pie - tiramisu

Appendix C

Statistical test related to table 2

(Significant results in bold)

Daily Food Intake 1: Comparison between groups					
Wilcoxon Rank Sum Test *p*-value		Volume	Volume Share	Budget	Budget Share
Low Income group *v.s.* Reference group	Fruits & Vegetables	0.1519	0.5292	**0.0780**	0.8000
	Other healthy food	**0.0013**	**0.0710**	**0.0122**	**0.0818**
	Unhealthy food	0.1230	**0.0562**	0.1792	**0.0291**
	Other food	0.2538	0.9544	0.1673	0.3879
	Total	**0.0827**	-	**0.0808**	-
Difference between Daily Food Intake 2 and 1: Comparison within groups					
Signed-Rank Test *p*-value		Volume	Volume Share	Budget	Budget Share
Low Income group	Fruits & Vegetables	**0.0474**	0.1048	**0.0435**	**0.0340**
	Other healthy food	0.9896	0.6440	0.5073	0.7510
	Unhealthy food	0.4874	0.5402	0.3869	0.2320
	Other food	0.2263	0.1060	0.8972	0.7064
	Total	0.4923	-	**0.0471**	-
Reference group	Fruits & Vegetables	**<0.0001**	**<0.0001**	0.6295	0.2383
	Other healthy food	0.9926	0.4317	0.7075	0.2312
	Unhealthy food	0.9357	1.0000	0.6156	0.6043
	Other food	**0.0473**	**0.0011**	**0.0536**	0.3170
	Total	0.1244	-	**0.0399**	-
Difference between Daily Food Intake 2 and 1: Comparison between groups					
Wilcoxon Rank Sum Test *p*-value		Volume	Volume Share	Budget	Budget Share
Low Income group *v.s.* Reference group	Fruits & Vegetables	**0.0096**	**0.0545**	0.1313	**0.0319**
	Other healthy food	0.8873	0.7937	0.5238	0.4925
	Unhealthy food	0.5561	0.6689	0.3225	0.5400
	Other food	0.4186	0.1504	0.1212	0.1930
	Total	0.2906	-	0.6969	-
Difference between Daily Food Intake 3 and 1: Comparison within groups					
Signed-Rank Test *p*-value		Volume	Volume Share	Budget	Budget Share
Low Income group	Fruits & Vegetables	**0.0055**	**0.0081**	0.1313	0.7987
	Other healthy food	0.6768	0.5631	**0.0008**	**0.0171**
	Unhealthy food	0.1974	0.2451	0.8017	0.3030
	Other food	0.5358	0.6403	0.7201	0.3591
	Total	0.7882	-	**0.0254**	-
Reference group	Fruits & Vegetables	**0.0147**	**0.0320**	0.9146	**0.0118**
	Other healthy food	**0.0082**	0.1717	0.5735	0.5495
	Unhealthy food	**0.0340**	**0.0162**	0.2012	0.3299
	Other food	0.2046	**0.0847**	**0.0222**	0.3127
	Total	**0.0815**	-	**0.0155**	-
Difference between Daily Food Intake 3 and 1: Comparison between groups					
Wilcoxon Rank Sum Test *p*-value		Volume	Volume Share	Budget	Budget Share
Low Income group *v.s.* Reference group	Fruits & Vegetables	0.5850	0.8249	0.4024	0.1061
	Other healthy food	**0.0342**	0.1648	0.2509	**0.0866**
	Unhealthy food	0.4907	0.4734	0.2056	0.1614
	Other food	0.4700	0.2555	0.0897	0.1771
	Total	0.1657	-	0.2242	-

Appendix D

Statistical test related to table 3

(Significant results in bold)

Daily Food Intake 1 (before policy): Comparison between groups			
Wilcoxon Rank Sum Test *p*-value		-30% Fruits & Vegetables	-30% F&V and OHF; +30% UF
Low Income group	Subsidy	**0.0780**	**0.0116**
v.s.	Tax	-	0.1792
Reference group	Prices Index	0.8000	**0.0857**
Daily Food Intake 2 & 3 (after policy): Comparison between groups			
Wilcoxon Rank Sum Test *p*-value		-30% Fruits & Vegetables	-30% F&V and OHF; +30% UF
Low Income group	Subsidy	**0.0017**	**<0.0001**
v.s.	Tax	-	**0.0003**
Reference group	Prices Index	**0.0084**	**<0.0001**
Difference between Daily Food Intake 2 & 3 and Daily Food Intake 1: Comparison within groups			
Signed-Rank Test *p*-value		-30% Fruits & Vegetables	-30% F&V and OHF; +30% UF
Low Income group	Subsidy	**0.0673**	0.2365
	Tax	-	0.1126
	Prices Index	0.2867	**0.0325**
Reference group	Subsidy	**0.0004**	**0.0007**
	Tax	-	**0.0103**
	Prices Index	**0.0001**	**<0.0001**
Difference between Daily Food Intake 2 & 3 and Daily Food Intake 1: Comparison between groups			
Wilcoxon Rank Sum Test *p*-value		-30% Fruits & Vegetables	-30% F&V and OHF; +30% UF
Low Income group	Subsidy	**0.0105**	**0.0032**
v.s.	Tax	-	0.3672
Reference group	Prices Index	**0.0130**	**0.0201**

Appendix E

Effects of Price Policies on Nutritional Content of Meal Choices

	Market Prices (Food day 1)			**-30% F&V** Difference from the baseline (Food day 2)			**-30% F&V and OHP; +30% UP** Difference from the baseline (Food day 3)		
	Poor	Non-poor	*p*-value	Poor	Non-poor	*p*-value	Poor	Non-poor	*p*-value
SFA (g)	25.56	22.26	0.1902	-2.00	-0.07	0.4244	-1.83	-2.81***	0.0333
Added sugars (g)	46.48	37.23	0.1634	-4.48	-4.42	0.0636	-8.11	-1.25	0.3120
Na (mg)	2939.60	2929.25	0.2462	-239.33**	-33.64*	0.1858	+5.92	-222.76***	0.0008
Fiber (g)	14.83	15.44	0.0489	+0.74***	+2.5**	0.0332	+0.55**	+2.23***	0.0283
Ca (mg)	674.40	727.83	0.0081	+38.18***	+22.85	0.0431	+3.36	+17.2	0.3281
Fe (mg)	8.50	9.18	0.0246	+0.14**	-0.08***	0.0478	+0.12*	-0.27	0.0258
Vitamin A (mg)	983.69	772.99	<0.0001	+167.48***	+443.08***	<0.0001	+279.04***	+342.97***	0.1237
Vitamin B6 (mg)	1.20	1.40	<0.0001	+0.10***	+0.18***	0.1661	+0.10***	+0.15***	0.3548
Vitamin B12 (µg)	3.93	4.62	<0.0001	-0.37***	-0.34***	0.2445	-0.08	+0.57***	<0.0001
Vitamin C (mg)	82.02	82.29	0.1888	+32.2***	+41.86***	0.1252	+30.54***	+37.2***	0.1249
Vitamin D (µg)	1.36	1.96	<0.0001	-0.01	-0.94***	<0.0001	-0.05	-0.68***	<0.0001
Vitamin E (mg)	7.67	7.20	0.2837	-0.63**	+0.37**	0.0040	-0.51*	+0.03	0.1507

Nutrient content of individual food day at market price and under price manipulations for poor and non-poor[6]. Values are energy adjusted.
p-value: Wilcoxon rank sum test against null hypothesis of no differences between income groups
***; **; *: Wilcoxon signed-ranked against null hypothesis difference from baseline with significance at the level of respectively 1%, 5% and 10%.

[6] Nutrient also available : Proteins, fat, cholesterol, polyunsaturated fatty acids, monounsaturated fatty acids, carbohydrates, Mg, K, thiamin, riboflavin, niacin, folates.