

**TRENDS AND INEQUALITIES IN FRUITS AND VEGETABLE PURCHASES
IN FRANCE BETWEEN 2002 AND 2010
IN THE CONTEXT OF THE NATIONAL NUTRITION AND HEALTH PROGRAM**

Gaëlle Jamet^{*∅}

Fabrice Etilé^{*°+}

Andres Silva^{*}

^{*}UR 1303 Alimentation et sciences sociales (ALISS)
French National Institute for Agricultural Research (INRA)
65 boulevard de Brandebourg
94205 Ivry-sur-Seine

[°] Paris School of Economics (PSE)
48 boulevard de Jourdan
75014 Paris, France

⁺ Centre for Health Economics
Monash University
Clayton, Melbourne
Victoria, 3800, Australia

[∅] Academic Unit of Health Economics
University of Leeds
UK

Corresponding author: gaelle.jamet@ivry.inra.fr. The authors wish to thank Andrew Clark, Florence Jusot and Sandy Tubeuf for their comments on early version of this paper. We also thank seminar participants at INRA-ALISS and University Paris-Dauphine “Health Chair PhD students’ workshop”.

Background

In France as in other countries, the public health authorities are concerned with the increasing prevalence of obesity and the related decline in physical activity and increase in sugar, fat and calories intake. In this context, a National Nutrition and Health Program has been implemented since 2001 to promote the consumption of 5 servings of fruits and vegetables per day.

Aims

In this policy context, this paper aims at documenting the evolution of purchases in F&V between 2002 and 2010, with a focus on the role of confounding factors, such as education, income and unit prices, and a close look at inequalities between households and between social groups.

Methods

We use "Recentered Influence Function" (RIF) regressions to decompose the contribution of changes in population income and education and trends in unit prices to the distributional changes in the purchases of F&V. We disentangle the composition effect (the changes due to changes in the covariates) and the structure effect (the changes due to a change in the educational gradient in F&V purchases and changes in the effects of other covariates).

Data

We use data from the 2002 and 2010 Consumer TNS Worldpanel, which cover the food representative sample of 13,000 French households via barcode scanning.

Results

The primary results show, that in the absence of demographic and economic changes between 2002 and 2010, the average quantity purchased observed in 2010 would have been 9 kg less for the fresh fruits and 4 kg less for the fresh vegetable. However, there has been a number of changes over the period including a rise in average income and education and a decrease in the unit prices (unit values) of fresh F&V, which have had a significant contribution to these increases in purchases. A decrease in the unit prices of fresh F&V has also significantly contributed to the increase in purchases, especially for the households in the lower quantiles of the distribution. The inequalities between households have reduced over time period according to the Gini index. Except for the fresh fruits, there has been no increase in education-related inequalities, and the income concentration index of purchases suggests that inequalities between income groups have reduced.

Conclusion

The consumption of fruits and vegetables has increased in France between 2002 and 2010. Although we cannot attribute this increase to a causal effect of the National Health Nutrition Program, we note the important contribution of the composition effect produced by the decrease in unit prices observed in our sample. However, external data suggest that the supply prices have increased at the national level over the same period: households purchase more F&V, but cheaper items of lower quality. In terms of inequalities, good news is that the "5-a-day" campaign is not associated with an increase in inequalities between households or between social groups.

Key words: 5-a-day; Fruits and Vegetable, Decomposition analysis, Health inequality, Price.

1. Introduction

During the past decade, public health authorities have been concerned with the increasing prevalence of obesity. In France in 2006, 41 % of men and 23.8 % of women were overweight and 16 % of men and 17.6% of women were obese. This represents a doubling of the prevalence of obesity among adults over the last 15 years¹. Obesity trends are publicised by public authorities to promote wider objectives of nutritional health obesity, and the prevention of food-related chronic diseases such as diabetes, colon cancer or hypertension (WHO, 2003). In this context, a key public health objective is to encourage a regular and high consumption of fruits and vegetable for their health-protective role (Hung, Joshipura, and al 2004, He, Nowson, and al 2007). French Health authorities have set up the National Nutrition and Health Program (NNHP) in 2001 to encourage the population to eat five servings of fruits and vegetables (F&V) per day at least. In this context, this research examine the evolutions of F&V purchases in French households between 2002 and 2010, with a particular focus on the distributional changes and the trends in inequalities between individuals and social groups.

Many developed countries (United Kingdom, Italy, Australia, Nordic countries) have implemented programs promoting F&V consumption. A literature review (Pomerleau, Lock K et al. 2005) states that general information campaigns may increase F&V consumption by 0.2 to 0.6 servings per day per person. In Australia, the campaign undertaken between 2002 and 2005 would have increased the average servings of F&V per day per person by 0.8 units (Pollard et al. 2008). In France, the stakeholders of the 5-a-day campaign states that some objectives have been partially or fully achieved, including increase consumption of F&V².

However, these claims can easily be challenged for two reasons at least. First, the causal evaluation of the campaign is extremely difficult in the absence of a control group that would not have experienced the NNHP. Second, there have been a number of changes over the same period, such as changes in market conditions and variations in the characteristics of the population (income growth, ageing, education expansion). Capacci and Mazzocchi (2011) are the first to propose a study that control for changes in market conditions in the context of the UK 5-a-day campaign. Using a before-after comparison of consumer behaviours, they find that the increase in F&V consumption observed at the time of the campaign could have been higher, would have F&V prices not increase. Hence, changes in market conditions, but also changes in a number of individual and environmental factors may act as confounding factors in any attempt to evaluate the NNHP in a non-experimental setting.

Rather than attempting to produce a causal evaluation NNHP, we here examine directly the contribution of a number of factors to changes in the overall and unconditional distribution of F&V purchases for at-home consumption between 2002 and 2010. Looking at the whole distribution is all the more interesting that the policy target aims at producing

¹ National Health and Nutrition Survey 2006-2007. The data of height and weight used to calculate the Body Mass Index (BMI = weight in kg / height in meters squared) were measured directly by the investigators, and are therefore exempt from reporting bias. A person BMI greater than 25 is overweight. A person BMI greater than 30 is obese.

² Ministry of Labor, Employment and Health, National Nutrition and Health Program 2011-2015, July 2011

behavioural changes in ‘low’ consumers. Hence, the focus here is more on inequalities between households than on inequalities between social groups.

We also examine the trends in social inequalities in F&V purchases. Public health policies have the explicit goal of reducing social inequalities in health³. Since the late 70’s, the upper classes showed a higher consumption of vegetable and a more varied diet than the lower social classes (Grignon 1984). More recently, the survey from the National Cancer Institute (INCA) showed that low-income and/or less educated individuals consume less F&V. Purchases of F&V of French households in the first income quartile are also lower than those of the general population. The income-richest 15% households buy 12 kg more than the poorest 15% households, everything else being equal (Bertail and Caillavet, 2008; Plessz and Gojard, 2010).

It is well-known that public health policies may unintentionally increase the social gaps, as the well-off tend to follow more closely the health recommendations in developed countries (Cutler and Glaeser, 2010; Etilé, 2013). We thus ask whether over this decade of F&V promotion, there has been an increase in the existing social gradient in F&V purchases. The social gradient will not be measured primarily in terms of income, but in terms of education, as education is a key determinant of long-term social inequality in health (Cutler and Glaser, 2010).

We use a decomposition approach to distributional changes that extends the traditional Oaxaca-Blinder decomposition of changes in means. It relies on estimates of “Recentered Influence Function” regression (RIF), following a method developed by Fortin, Lemieux et al (2011) This regression technique has recently been applied to the distributional analysis of wage, BMI and happiness (Joliffe, 2011; Etilé, 2013; Becchetti, Massari et al., 2013). The effects of changes in the characteristics of the population (composition effects) and changes in returns to these characteristics (structure effect) can be identified not only at the mean of the unconditional distribution of purchases but also at different quantiles of the distribution. Estimates of the structure effects for education and income allow us to identify the changes in social gradients along the distribution of purchases. We complement this analysis by a decomposition of the Gini, to see whether, beyond social inequalities, overall inequalities (inequalities between households) varied or not⁴.

The analysis reveals a significant increase in the purchases of F&V, +20.63 kg/household/year on average. This result is essentially due to a strong increase in the purchases of fresh products. This increase is observed along the whole distribution for the fresh products, while the distributions show little changes for the processed products. The increase in purchases is associated with a reduction in inequalities between households (a lower Gini), and a significant increase in education-related purchase inequalities for the fresh

³ Haut Conseil de la Santé Publique, « Les inégalités sociales de santé : sortir de la fatalité » Décembre 2009

⁴ We distinguish overall inequalities measured between any individuals whatever their social status or class, and the social inequalities observed between different social groups. The Gini index, determined by the covariance between the level of household purchase and the household rank in the distribution of purchases measures overall inequalities. Social inequalities can be measured by the covariance between household purchases and the rank in the distribution of socioeconomic status (for more and references, see Etilé, 2013). The Concentration Index is a more refined measure of social inequalities that we use for robustness tests in Section 6.

fruits only. The distributional trends are significantly related to important composition effects, notably the rise in the education level of the population and the decline in the unit prices of purchases (the household expenditure divided by the quantity purchased). The fall in unit prices has had a significantly positive and relatively larger impact on the fresh F&V purchases of 'low' consumers, which are also more likely to be low-income households. Given the positive time trend in the real prices observed in shops, the decline in unit prices reflects a substitution toward relatively lower-quality F&V. The low and poor consumers conformed to a policy recommendation formulated in terms of quantity (5-a-day) by downgrading the relative quality of their purchases. This has limited the widening of social inequalities that such information campaigns may, in theory, produce.

The paper is organized as follows. Section 2 presents the main economic factors and mechanisms that may theoretically affect household purchase of F&V and social inequalities in that domain. Section 3 describes the data. Section 4 explains the methods. Section 5 and 6 present and discuss the results. Section 7 concludes on the potential consequences of our findings for the cost-benefit evaluation of 5-a-day programs.

2. Prices, inequalities and the full price of consumption

A preliminary look at the data suggests that social inequalities between households in the purchase of F&V reduced over the last decade. This trend could be attributed to the NNHP, but they could equally have been produced by a number of other confounding determinants.

There might have been changes in tastes unrelated to the program, and produced by changes in the social and age structures of the population and the social norms of consumption attached to these structures (Bourdieu, 1979, Grignon and Grignon, 1999). For instance, there has been an important ageing of the population, and the elderly and the older cohorts tend to eat more F&V. Or, there are more white collars now than ten years ago, and white collars are more oriented toward light and healthy food than blue collar.

Various mechanisms have also been put forth by the economic literature to explain the heterogeneity and social inequalities in consumption of F&V and, more generally, health behavior. Four mechanisms are of particular interest: the budget constraint, differences in the opportunity costs of health behaviors the accessibility of supply and 'objective' physiological constraint.

Regarding the budget constraint, our data suggest that the real unit prices of fresh F&V has declined over the last decade. If this were to reflect a decline in the supply price (the price observed in shops), then we expect that the relaxation of the budget constraint has made the less advantaged households more able to purchase F&V. These households effectively face a tighter budget constraint. In 2006, total food expenditures represented 21% of the

consumption budget for low-income households, and their spending on F&V account for 12 % of total food expenditures⁵.

However, the importance of the budget constraint is tempered by a number of other factors that determine a "full" price of consumption (the marginal utility of current optimal choices at the equilibrium).

This full price of consumption is likely to depend on the health consequences of consumption choices. Here, differences in education are the main channel of transmission of inequality in health behaviors (Grossman, 1972, 2000; Cutler and Glaeser, 2010)⁶. An increase in the level of education increases the marginal productivity of inputs contributing to the formation of health capital, i.e. the amount of inputs required to achieve a given health capital is lower (productive efficiency). Thus, a prevention campaign would be more effective in the more educated part of the population because they would better understand the messages. But a higher level of education also increases the probability of choosing health-enhancing inputs (allocative efficiency). The reason is that, for a given level of information, the more educated have more to lose in terms of life expectancy or future revenues, in adopting health-damaging behaviors. Social inequalities in health behaviors crucially depend on differences in the opportunity costs associated with these behaviors. These opportunity costs increase the full price of consumption.⁷

Spatial inequalities may also affect the full price of consumption and reinforce social inequalities. The food supply somehow varies depending on where one lives. The term "food deserts" is commonly used in epidemiological studies to refer to the lack of supermarkets or retail stores selling F&V in disadvantaged residential areas. A limited access to the supply of F&V increases the full price of consumption for low-income households, because they have to spend more time to access these products. There are mixed evidence on the impact of food deserts on food behavior and nutritional outcomes in the literature. Food deserts have been found to be an important determinant of social inequalities in F&V consumption in Finland and the United States (Morland, Wing and Roux, 2002, Moore, Diez and Roux, 2006). Studies in Australia (Winkler, et al) and in the UK suggest the converse. To our knowledge, this hypothesis has not been tested in France.

⁵ « Les fruits et légumes dans l'alimentation. Enjeux et déterminants de la consommation » Expertise scientifique collective INRA 2007

⁶ Grossman considers health as a special capital since, unlike financial or physical capital, it directly affects the individual well-being. The health capital stock increases by making good investments (eating "healthy food") and depreciate with time (ageing) and bad investments (eating "junk" food). Health capital investments have a cost, which is the sum of a market costs (e.g. purchasing F&V) and some opportunity costs. The latter term includes factors such as the time spend at shopping, but is also ambiguous. For an individual oriented towards present pleasures and liking fat and sweet food, giving up junk food for fruits and vegetables to gain a few years of life expectancy represents an opportunity cost. Conversely, for a future-oriented individual with the same food tastes, the opportunity cost is giving up a few years of life for immediate pleasures. In both cases, the loss is not "framed" in the same way and we know from Kahneman and Tversky that this has implications for individual choices. Moreover, the choice of a frame is in this case highly related to timepreference, and thus to an individual form of ethics promoted by public health : what is the attention I give to my future self (Frederick 2006)

⁷ Education may also be linked to health behaviors through other channels (see Cutler and Glaeser, 2010, for a thorough discussion). For instance, education increases patience, and therefore the expected benefits of healthy food choices and the discounted opportunity costs of unhealthy food choices (Becker and Mulligan, 1997).

Last, consumption choices are partly affected by physiological constraints. Everyone *must* take a minimum of calorie to stay alive and carry out one's daily activities. Low-income households have to purchase these calories at a reasonable cost. Foods high in fat and sugar have a monetary cost per calorie lower than that of "healthy" food (Darmon et al 2003, 2004). Hence, energy-dense foods tend to have a higher marginal utility and a lower full price. This explains that they are especially attractive for low-income households. The high market price of F&V combined with their low energy density makes them less attractive.

These four factors modulate the full price of consumption and explain individual and social differences and inequalities in purchase behaviors beyond potential differences in tastes. They explain why the direct price elasticity of F&V purchases is found to be lower in low-income households (Bertail and Caillavet, 2008), although a price change should a priori have more impact on the latter since their budget is more constrained. A decrease in prices may not translate into a decrease in the full price of consumption if access to food remains difficult or if the physiological constraint is not simultaneously relaxed.

These factors will also interact together to modulate the impact of prevention campaigns, which will therefore differ from one social group to another. Achieving the recommendation of the NNHP is subject to various conditions: being able to access and pay for F&V while having enough calories to eat; having the required education to understand the recommendations; and, as health inequalities are due, at least in part, to differences in opportunity costs, the more educated and wealthiest have more interest to conform their behaviors to the nutritional recommendations.

Given these theoretical considerations, the already mentioned decline in the unit price of fresh F&V should have resulted in a distribution of purchases shifting to the right, while overall inequalities in purchases should have reduced. There should also be a positive association between the variations in the education level of the population, which has increased over the period, and purchases, with a reduction of overall inequalities. Last, in the context of the NNHP campaign, we may observe a strengthening of the education-gradient gradient in purchases, holding other factors (especially unit prices) constant.

3. Data

We use the 2002 and 2010 waves of TNS-KantarWorldpanel, a representative panel of French households collecting exhaustive information on their food purchases, including F&V. This is a four years rotating panel and, therefore, the households observed in 2002 and 2010 are not the same. Each household has a home scanner to register the products that are purchased at each shopping trip. Purchases of package products are identified by a scan of the barcode. For products without barcodes (typically fresh fruits and vegetables bought loose in the supermarket or market), the meal planner records identifies the item on a list and records its weight and the corresponding expenditure. We have information about purchased quantities and expenditures, as well as a number of socio-demographic individual and household characteristics. The data are provided after having been corrected by TNS-KantarWorldPanel for reporting errors and measurement bias.

3.1. Outcome variables

We classified household purchases into 4 groups: fresh whole and unpeeled fruits, fresh vegetable, processed fruits (in syrup or stewed) and processed vegetable (frozen or canned, and soups). We excluded potatoes, which have a different nutritional value than vegetable.

This study considers only purchases for food at home. Individuals also consume F&V outside or may grow their own production. The total quantity available for consumption is therefore likely to be higher than the quantity purchased for at-home consumption. However, part of the overall purchases and home production is not actually consumed due to wastes; the French Environment and Energy Management Agency (EEMA) estimated that food waste represents 20 kilograms per person in 2012.

3.2. Main explanatory variables

Our sample consists of 12,866 households observed in 2002 or 2010. The households who provided less than 48 weeks of valid data in a year were excluded from the estimation sample.

We essentially use education level to capture social differences. The link between health and education has been widely documented. Drewnowski and Specter (2004) show that the impact of education on F&V consumption may be greater than income. Furthermore, our income measure is imprecise and potentially affected by transitory shocks (especially for the low-income households). Education level affects lifestyles and health behaviors directly, but also indirectly influences, as it determines social class membership and income. Hence, education is eventually the main social determinant of the opportunity costs related to health behaviors, as it shapes income streams over the lifecycle. Education is also correlated with health and nutritional knowledge, which are likely to impact the purchases of healthy food like fruits and vegetables (Variyam, Blaylock & al 1998).

We additionally control for the social class of the meal planner and real household income per unit of consumption.

We also control for the age and the gender of the meal planner. Age is strongly correlated with the consumption of F&V. Data from the French INCA dietary survey have shown a significant correlation between age and the quantity and the diversity of F&V consumption. There is an increase of F&V consumption until 65 years old but, there is no difference between men and women. In northern European countries, there is also a lower consumption of F&V among young adults. However, there is no consensus in the international literature on the consumption of older people, which can be higher or lower than middle aged people depending on the country⁸. Beyond age effects, there is some evidence of specific cohort effects: the younger generations consume less F&V than their older counterparts at a given same age⁹.

⁸ « Les fruits et légumes dans l'alimentation. Enjeux et déterminants de la consommation » Expertise scientifique collective INRA 2007

⁹ « Les fruits et légumes dans l'alimentation. Enjeux et déterminants de la consommation » Expertise scientifique collective INRA 2007

The Table 1 below presents some descriptive statistics for the estimation sample. The average age of the sample was 53.5 years old in 2010, 3 more years than in 2002. Individuals with the Baccalaureate (UK A-level) represented 22% of the sample in 2010, as against 14% only in 2002. These massive shift reflects the ageing of the population, and the impact of the two and third phase of the educational expansion in France. Education policies have promoted a greater access to the Baccalaureat level (via the creation of professional and technical Baccalaureats), and favored university enrollments.

TABLE 1. SAMPLE CHARACTERISTICS IN 2002 AND 2010

	2002	2010
<i>Age (std error)</i>	50.21 (0.27)	53.53 (0.15)
<i>Log Real Income/unit of consumption in kEuros</i>	1173 (10.87)	1380 (6.40)
<i>Gender</i>		
Male	6.7 %	11.83 %
Female	93.3 %	88.17 %
<i>Education level</i>		
Primary school	12.21 %	7.43 %
Secondary school	5.01 %	6.41 %
Youth Training /BTEC	34.27 %	27.17 %
Baccalaureate (UK A-level)	13.87 %	21.89 %
Higher Education degrees	6.46 %	16.79 %
Graduate level	11.71 %	15.33 %
Unknown	16.47 %	4.98 %
<i>Socio-professional status</i>		
Farmers	2.44 %	1.16 %
Self-employed	2.74 %	2.06 %
Executive	7.41 %	9.11 %
Intermediate professions	18.34 %	16.78 %
Clerks, office workers	18.06 %	17.89 %
Skilled and unskilled workers	21.58 %	16.4 %
Retired	25.81 %	34.63 %

4. The “5-a-day” campaign, aggregate trends in purchases and the unit prices of F&V

4.1. The French National Nutrition and Health Program and the “5-a-day” campaign

The National Nutrition and Health Program was launched in 2001 for five years, and extended two times for five more years in 2006 and 2011. Between 2001 and 2006, the main actions were to provide nutritional guidelines to the French population through messages in media, TV spots, a dedicated website (www.mangerbouger.fr), and leaflets distributed in schools and health care centres.

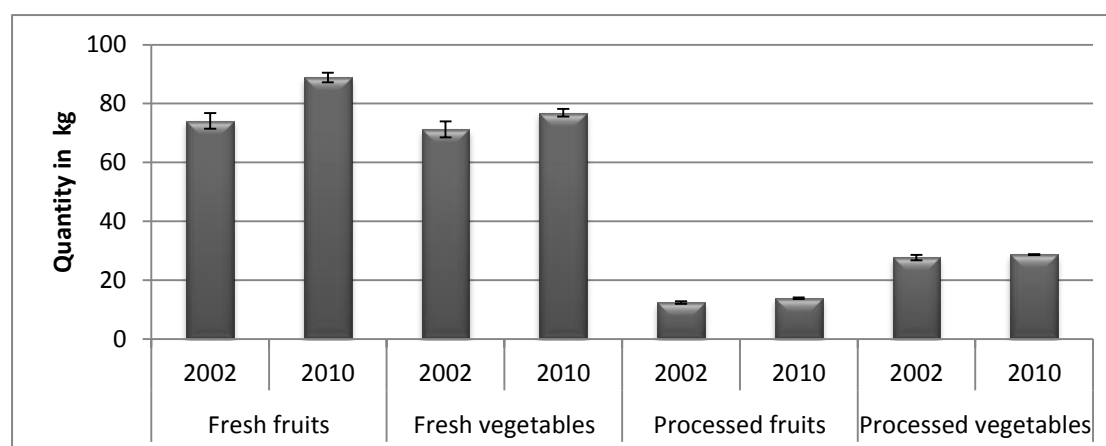
The key objective is to encourage people to eat, at least, five servings of fruits and vegetables every day, with the slogan “For your health, eat at least five fruits and vegetable in a day”. In June 2003, a specific booklet “Health comes eating” was issued at 1.5 million copies. In 2008, the National Institute for Prevention and Health Education (INPES)

broadcasted TV ads and web banners about the 5-a-day recommendation. All these actions targeted the entire population. Since 2006, the less advantaged population is also targeted through specific actions, such as the distribution of short leaflets in community health centers. Some hours of nutritional education are also given to students in primary and secondary schools.

4.2. The evolution of F&V purchases between 2002 and 2010

Figure 1 below shows that the purchases of fresh F&V have significantly increased between 2002 and 2010. The purchases of fresh fruits increased from 74 to 88kg and the purchases of fresh vegetable increased from 71 to 76 kg. The purchases of processed fruits increased from 12 to 14kg while those of vegetables remained stable around 27 kg.

FIGURE 1. CHANGES IN AVERAGE HOUSEHOLD PURCHASES BETWEEN 2002 AND 2010



By dividing the quantity purchased in the year by 365, the size of the household, and the NNHP definition of a serving (80g), we obtain the number of servings available per day per person for consumption at home. Between 2002 and 2010, the number of servings of fruits and vegetable available per day per person has increased from 2.79 to 3.55 for a public health target of 5 servings. Table 2 reports the changes in yearly purchases (in kg per capita) between 2002 and 2010 by product category. There has been an increase of about 38% for the fresh fruits, 20% for the fresh vegetable and between 25 and 28% for their processed counterparts.

TABLE 2. TOTAL AVERAGE QUANTITY PURCHASED PER PERSON, 2002-2010

Year	Fresh fruits	Fresh vegetables	Processed fruits	Processed vegetable
2002	33,21	31,78	4,89	10,36
2010	46,09	38,42	6,25	12,92

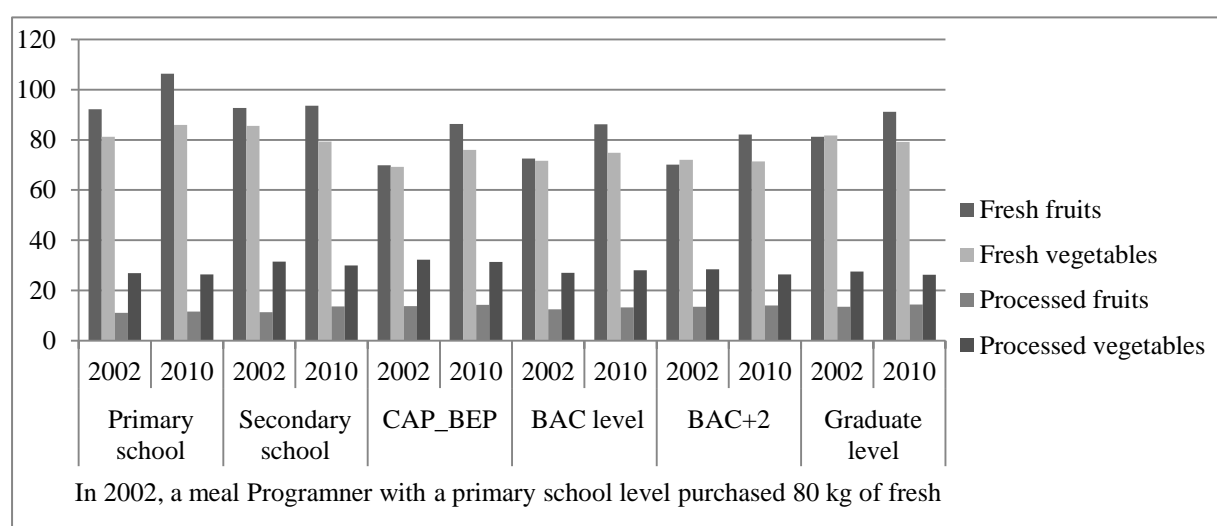
Of course, these numbers do not take into account waste, nor do they make a difference between adults and children.

4.3. Changes in social inequalities between 2002 and 2010

The epidemiological and economic literature has clearly documented the social gradient in food and nutrition behaviours: the poorest and least educated tend to eat more fat, more sugar and less fruit and vegetables.

Here, however, the raw statistics displayed in Figure 2 below suggest that the households whose meal planner has a primary school degree purchase more fresh fruits and vegetables (106kg and 86kg respectively in 2010), just before the households whose meal planner has a graduate level.

FIGURE 2. TOTAL MEAN QUANTITIES PURCHASED PER HOUSEHOLD AND EDUCATION OF THE MEAL PLANNER



In terms of variations, the Figure 3 below suggests that the increase in F&V purchases is largest for individuals with a Youth Training/BTEC. There was an increase of about 25% for the fresh fruits and 10% for the fresh vegetable. We also note a small decline in the purchase of processed vegetable across all education levels. This could reflect a substitution toward fresh products.

The Figures 2 and 3 do not show a clear association between education and the levels of or changes in consumption. However, the age of the meal planner is an important confounding factor. Younger people are on average more educated than older people. Hence, meal planners from the old generations are more likely to have only a primary school degree and to have a stringer taste for F&V. Looking at the group of middle-aged meal planner (aged 50-65), we note on Figure 4 that the consumption of fresh products in 2010 is greater for individuals with a graduate degree. The households whose meal planner has a secondary school degree are those where purchases of fresh fruits were the lowest in 2010. The

households whose meal planner has a primary school degree have the lowest purchases of fresh vegetable in 2010. The social gradient in the consumption of fruits and vegetable thus appears only after controlling for the effect of age.

FIGURE 3. EVOLUTION OF PURCHASES PER HOUSEHOLD AND EDUCATION OF THE MEAL PLANNER

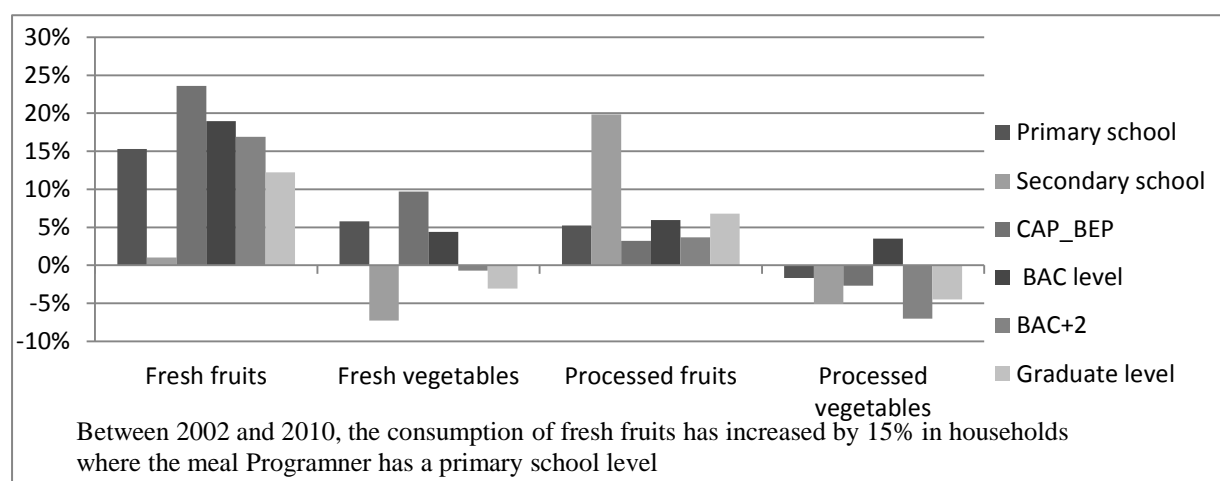
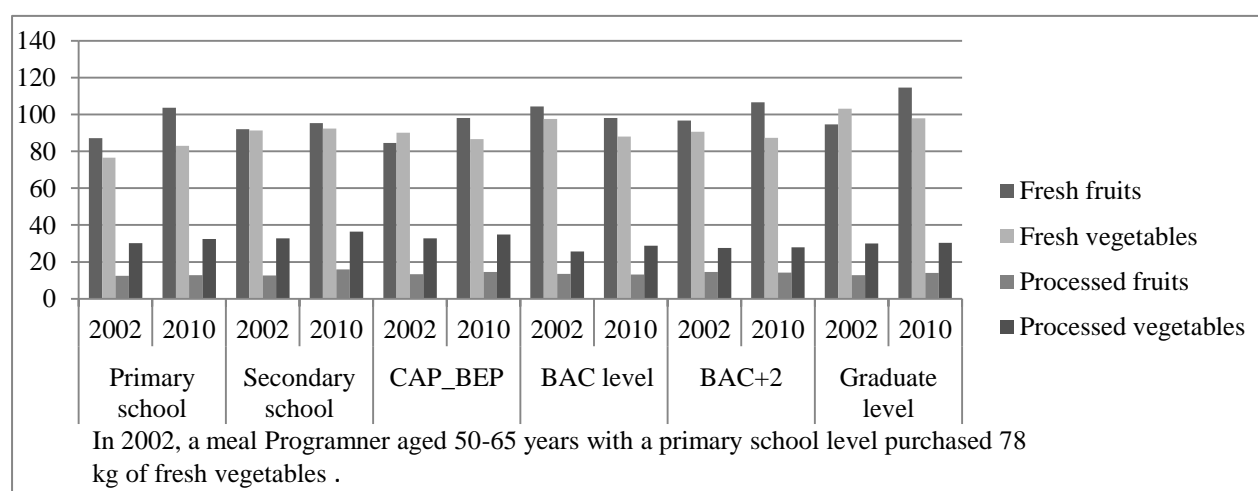


FIGURE 4. CHANGES IN THE AVERAGE HOUSEHOLD PURCHASES WHEN THE MEAL PLANNER IS AGED 50-65 YEARS



4.4. Unit prices, true prices and the quality of purchases

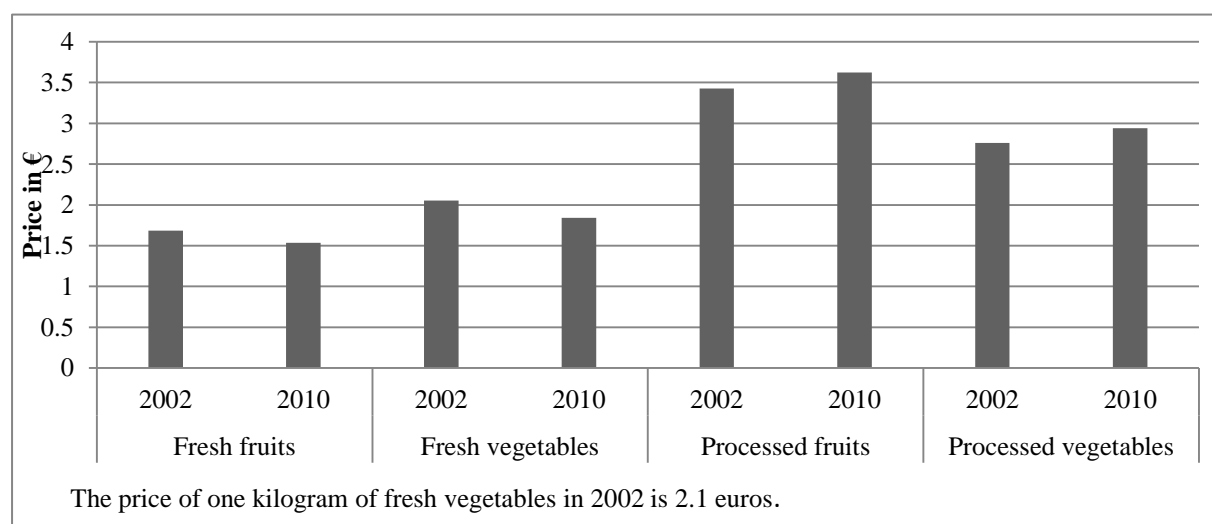
These statistics clearly show an increase in F&V purchases between 2002 and 2010. However, we are cautious in interpreting these changes as causal evidence. The NNHP actions described above are carried out at the national level, and so the entire population was exposed to the prevention intervention. Hence, we do not have any control group to assess the causal impact of the NNHP on F&V purchases. There are many confounding factors that may explain these trends, especially changes in market conditions.

Cappaci and Mazzocchi (2011) examine the role of prices as a potential confounder of the 5-a-day campaign impact on the evolution of the purchases of F&V by UK households. They find that an increase in the real price of F&V has mitigated the positive impact of the 5-a-day campaign, possibly because the increasing demand has exerted a pressure on a relatively inelastic supply. Hence, accounting for “market forces” is a key issue when one wants to delve into the dynamics of consumption and inequalities. Here, we examine the evolution of prices over the period.

Dividing household expenditures by the purchased quantities yields a unit price also called unit value in the consumption literature (Deaton, 1988). Variations in unit prices between households and over time may reflect (i) variations in real prices holding quality constant, and (ii) variations in the quality of F&V chosen by households. For instance, the products marketed as “superior” or “organic” or coming “directly from the farm” are likely to be more expensive (though not necessarily better in terms of nutritional quality). Consumers of organic F&V will report higher unit prices than consumers of conventional products.

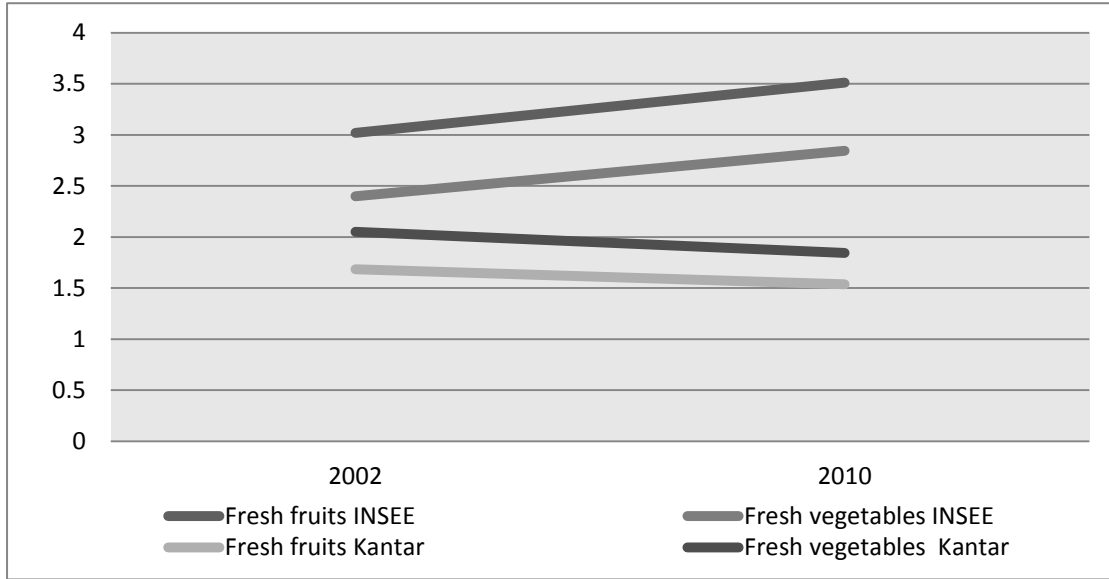
Moreover, the unit prices vary geographically, holding quality constant, as a function of the average willingness-to-pay of consumers observed by providers in a retailing zone. Aggregated over all households, the unit prices provide a good indication of variations in real prices, only if the quality of supply has little variation. Assuming no changes in quality, there would have been decline in the prices of fresh products between 2002 and 2010 while that of processed products has tended to increase, as shown by the Figure 5 below.

FIGURE 5. EVOLUTION OF AVERAGE UNIT PRICES IN EUROS, 2002-2010 (EUROS 2002)



Yet, the variations in average unit prices that are observed in our sample contradict the variations computed from series of average real prices observed in shops over the period for a quality-constant basket of products (INSEE). The Figure 6 compares the rise in the real prices of fresh F&V (in euro/kg) observed in shops to the decline of unit prices observed in the data over the same period.

FIGURE 6. PRICES OF FRESH F&V AS REPORTED BY INSEE AND OBSERVED IN THE DATA



The decomposition analysis uses the unit prices but we interpret the results being aware that the changes in unit prices reflect both changes of quality and “true” prices. In particular, for the fresh F&V, there has been an increase in the “true” prices of F&V and, therefore, a significant decrease in the relative quality of purchases.

5. Method

Decomposition methods can be used to analyse distributional changes over time. This section presents a Oaxaca-Blinder decomposition method using Recentered Influence Functions (RIF) regressions for decomposing the distributional changes in purchases of F&V over time into composition and structure effects. The composition effects measure the contribution of changes in the distribution of covariates to changes in the distribution of purchases. The structure effects measure the contribution of changes in the returns to these covariates (their association with purchases), holding their distributions at their initial level.

5.1. Oaxaca-Blinder Decomposition

The Oaxaca-Blinder approach applied to OLS estimates is traditionally used to decompose the difference in mean of an outcome Y between two groups A and B.

Suppose purchases C are observed at two points in time, 2002 and 2010, and that household purchases are related to covariates X as follows:

$$C_{i,t} = X_{i,t} \beta_t + \varepsilon_{i,t} \quad \text{with } t = 2002, 2010 \quad (1)$$

Here $C_{i,t}$ is the quantity purchased by a household i in year t , $X_{i,t}$ is a set of covariates, whose association with purchases is measured by β_t : these coefficients represents the *returns* to

household-specific characteristics. $\varepsilon_{i,t}$ is an heteroscedastic error term which captures the residual influence of all unobserved characteristics. The mean of $\varepsilon_{i,t}$ is zero implying that:

$$E(C_{i,2002}) = E(X_{i,2002}) \hat{\beta}^{2002} \quad (2)$$

$$E(C_{i,2010}) = E(X_{i,2010}) \hat{\beta}^{2010} \quad (3)$$

where E is the expectations operator. The variation in average purchases between 2010 and 2002 can be written as:

$$E(C_{2010}) - E(C_{2002}) = \underbrace{E(X_{2010} - X_{2002}) \hat{\beta}^{2010}}_{\Delta^C} + \underbrace{E(X_{2002}) (\hat{\beta}^{2010} - \hat{\beta}^{2002})}_{\Delta^S} \quad (4)$$

The first term in the right hand side, Δ^C , refers to the overall composition effects. It provides an answer to the following question: given the characteristics of the population in 2002, how are changes in population related to changes in the average purchases? The second term Δ^S is the overall structure effect. It measures the contribution of changes in the structure of returns to changes in the mean purchased quantities. The structure effects of variables such as education or income characterise the evolution of social inequalities over time. OLS regressions by period and estimate $\hat{\beta}_{2002}$ and $\hat{\beta}_{2010}$ can be used to estimate the counterfactual means, i.e. the mean of consumption observed at t=2010 in a population with characteristics observed in 2002, $(E(X_{2002}) \hat{\beta}^{2010}$ in Equation 4).

5.2. RIF regressions

OLS regressions only allow for a decomposition of changes in the mean of a distribution. We analyse here the changes in the *entire* distribution of F&V purchases. The mean is likely to be a poor indicator of these changes if the distribution is non-normal (e.g. skewed with some very “high” consumers). Moreover, from a public health point of view, it is more interesting to look at “low” consumers, at the bottom of the distribution. Fortin, Lemieux et al (2011) propose a decomposition technique for the analysis of distributional changes extending the Oaxaca-Blinder approach. Their method appeals to an unconditional estimator which produces a decomposition that identifies unambiguously the contribution of each covariate to the composition effect. They show that one can estimate the mean marginal effects of X on many statistics of interest by regressing an appropriate function called “Recentered Influence Function” (RIF) on the covariates. For most distributional statistics of interest v (the mean, the variance, the quantiles or the Gini), the value of the RIF for each household i observed in period t – $RIF(C_{i,t}, v)$ – can be estimated non parametrically from the data. Then, the impact of X on the conditional mean of the RIF is modelled using a linear additive specification:

$$E(RIF(C_{i,t}, v) | X = X_{i,t}) = \beta_{v,t} X_{i,t} + \delta_{v,t} \quad (5)$$

and $\beta_{v,t}$ and $\delta_{v,t}$ can be estimated by OLS regressions. If v_t is the value of the unconditional statistic at t , the law of iterated expectations implies:

$$v_t = E_X(E(RIF(C_{i,t}, v) | X = X_t)) = \beta_{v,t} E(X_t) + \delta_{v,t} \quad (6)$$

where $\beta_{v,t}$ represents the marginal effect of a change in a distribution of the vector X on the unconditional statistic v . This equation reproduces the logic of Oaxaca-Blinder procedure and allows a decomposition similar to (2):

$$v_{2010} - v_{2002} = \underbrace{E(X_{2010} - X_{2002})\hat{\beta}^{2010}}_{\Delta_v^c} + \underbrace{E(X_{2002})(\beta_{2010} - \beta_{2002})}_{\Delta_v^s} \quad (7)$$

5.3. Measuring inequalities

We use the Gini index to characterise overall inequalities, *i.e.* the inequalities between households that appear in the shape of the distribution. The Gini index is associated to the Lorenz curve which plots the cumulative proportion of a population ranked by F&V purchases against the cumulative proportions of purchases. It is defined as twice the area between the Lorenz curve and the line of equality (the 45-degree line). Its value is comprised between 0 (equal distribution) and 1 when all purchases are concentrated in one person. This Gini index measures inequalities between households whatever their social background.

The inequalities between social groups are reflected in the social gradient of purchases, *i.e.* in the coefficients associated to education or income. Hence, the trends in social inequalities can be assessed by identifying the structure effects of these covariates.

We also use, in the discussion, the Concentration Index (CI) (Kakwani, 1977, 1980) with reference to the concentration curve obtained when one ranks individual by income and not by F&V purchases. The CI equals twice the area between the concentration curve and the line of equality. It is equal to zero if there is no income-related inequalities in F&V purchases: whatever their income, all households purchase the same quantity of F&V. The CI takes negative value when the curve lies above the line of equality. Formally, it is defined as:

$$C = 1 - 2 \int_0^1 L_h(p) dp \quad (8)$$

The index is bounded between -1 and 1. The sign indicates the direction of any relationship between the variable of interest and position in the income distribution in our case.

6. Results

The Tables 3, 4, 5, and 6 present the results of the decomposition analysis for the four product categories: fresh fruits, fresh vegetable, processed fruits and processed vegetable. The changes in purchases are analysed through five statistics: the mean, the first decile (Q10), the median (Q50), and the last decile (Q90) and the Gini. The standard errors of the estimates appear in parentheses below the point estimates. The upper panel in each table shows the total quantities purchased in 2002 and 2010 and the observed difference. The middle and lower panels report respectively the composition and structure effects for income, unit prices and education only. All regressions control for the age of the meal planner, the household structure and the location of households (control list: age, gender, socio-professional status, quarter dummies, number of child, marital status and region dummies)

6.1. The significant contributions of changes in income, unit prices and education

The overall composition effect is positive and significant across the entire distribution of purchases for the fresh products. If the distribution of covariates had been unchanged, the mean purchases would have been lower (9.2 kg for fresh fruits and 4.7 kg for fresh vegetable). This would also have been the case for every unconditional quantiles. The overall composition effect is not significant for the processed fruits and negative for the processed vegetable.

The increase in real income between 2002 and 2010 has contributed positively and significantly to the increase in purchases of fresh F&V (Tables 3 and 4). This effect is found across the entire distribution, and is larger in absolute value in the higher quantile. It is however lower if we examine the relative contribution to the increase in consumption. For instance, for the fresh fruits, the rise in income corresponds to +7.02 kg at the 90th quantile, and +1.24 kg at the 10th quantile. But the 90th quantile has increased by +31.86 kg, and the composition effect of income represents 22.0% of this increase. The 10th quantile has increased by +4.18 kg, with a relative composition effect of income of 29.7%. The composition effect of income is significant only for low consumers (in the 10th quantile) for the processed fruits and vegetables (Tables 5 and 6).

The decrease in the unit prices of fresh F&V has contributed positively and significantly to the increase in purchases, with an absolute impact that is fairly uniform across the distribution (Tables 3 and 4): +0.811kg for the fresh fruits at the mean, and +0.530 at the first decile; +0.529kg for the fresh vegetables at the mean and +0.512 at the first decile. As a consequence, the *relative* contribution of the fall in unit prices is lower for the “high” consumers in the 90th quantile. These changes have had a relatively more important contribution to the rise of purchases observed for “low” consumers. As expected, the relative contribution of the increase in the unit prices of processed F&V is negative and significant (Tables 5 and 6).

The composition effect of education is consistent with the insights of Section 2 regarding the impact of information campaigns by educational level: the more educated are more likely to conform to the nutritional recommendations. The rise in education observed in the population has had a positive and significant impact on the purchases of fresh F&V (Tables 3 and 4). It is worth noting that this effect is higher in the upper quantiles, albeit less statistically significant. As with income and unit prices, the relative contribution of the composition effect of education decreases along the distribution. For the processed vegetable, there is a significant contribution of the rise in education to the decrease of purchases for low consumers only.

Regarding overall inequalities, the Gini index has slightly decreased between 2002 and 2010 from 0.477 to 0.463 for the fresh fruits (Table 3), and from 0.458 to 0.437 for the fresh vegetable (Table 4). This reflects a reduction of inequalities between households. The overall composition effect of covariates on overall inequalities is negative and significant.

TABLE 3. DECOMPOSITION FRESH FRUITS

Statistics	Mean	First decile Q10	Median Q50	Last decile Q90	Gini
Value 2002	75.66*** (1.409)	9.863*** (0.698)	53.96*** (1.301)	164.0*** (4.163)	0.477*** (0.00588)
Value en 2010	89.61*** (0.853)	14.04*** (0.417)	65.93*** (0.823)	195.9*** (2.360)	0.463*** (0.00299)
Evolution 2002-2010	13.95*** (1.647)	4.175*** (0.813)	11.97*** (1.540)	31.86*** (4.785)	-0.0132** (0.00660)
<i>Composition Effects</i>					
Income	2.625*** (0.614)	1.239*** (0.304)	1.722*** (0.552)	7.023*** (1.829)	-0.00300 (0.00256)
Unit price	0.811*** (0.216)	0.530** (0.231)	0.556* (0.333)	1.430 (0.941)	-0.00157** (0.000689)
Schooling level	2.437*** (0.864)	0.818* (0.433)	2.767*** (0.777)	3.600 (2.476)	-0.0116*** (0.00372)
Overall composition effect	9.204*** (1.218)	3.911*** (0.660)	8.786*** (1.146)	18.69*** (3.718)	-0.0284*** (0.00497)
<i>Structure Effects</i>					
Income	5.563 (28.00)	-4.480 (13.93)	37.88 (25.92)	-110.7 (82.93)	-0.161 (0.116)
Unit price	-11.24*** (2.113)	-7.848** (3.876)	-10.08* (5.615)	-14.13 (13.36)	0.0284*** (0.00855)
Schooling level	9.713** (4.744)	0.0944 (1.808)	4.447 (4.508)	35.70** (17.08)	0.0361* (0.0194)
Overall structure effect	3.040* (1.706)	-1.026 (0.984)	1.415 (1.688)	14.60*** (5.022)	0.00935 (0.00688)

***Significant at the 1%-level ** Significant at the 5%-level * Significance at the 10%-level, Standard errors in parentheses.

TABLE 4. DECOMPOSITION FRESH VEGETABLE

Statistics	Mean	First decile Q10	Median Q50	Last decile Q90	Gini
Value 2002	73.04*** (1.440)	11.93*** (0.697)	53.86*** (1.204)	155.3*** (3.219)	0.458*** (0.00737)
Value en 2010	77.79*** (0.672)	14.00*** (0.387)	59.99*** (0.699)	166.1*** (1.738)	0.437*** (0.00274)
Evolution 2002-2010	4.755*** (1.589)	2.072*** (0.798)	6.137*** (1.392)	10.73*** (3.658)	-0.0213*** (0.00787)
Composition Effect					
Income	2.714*** (0.634)	0.857*** (0.313)	2.552*** (0.524)	5.018*** (1.323)	-0.00554* (0.00329)
Unit price	0.529*** (0.173)	0.512** (0.231)	0.391** (0.169)	0.449** (0.205)	-0.00175** (0.000740)
Schooling level	2.985*** (0.894)	0.939** (0.426)	3.411*** (0.719)	4.349** (1.966)	-0.0108** (0.00472)
Overall composition effect	8.821*** (1.240)	2.817*** (0.647)	8.299*** (1.013)	14.79*** (2.710)	-0.0202*** (0.00613)
Structure Effect					
Income	-15.60 (27.24)	9.039 (14.29)	-11.54 (23.69)	-102.9* (60.38)	-0.0405 (0.141)
Unit price	-12.78*** (1.886)	-11.21*** (3.455)	-13.40*** (3.875)	-17.16*** (5.295)	0.0624*** (0.00916)
Schooling level	1.313 (4.521)	-0.809 (2.089)	-1.354 (4.046)	14.69 (12.28)	0.0131 (0.0230)
Overall structure effect	-1.799 (1.614)	-1.740* (0.921)	-0.143 (1.483)	1.141 (3.817)	-0.00201 (0.00817)

***Significant at the 1%-level ** Significant at the 5%-level * Significance at the 10%-level, Standard errors in parentheses.

TABLE 5. DECOMPOSITION PROCESSED FRUITS

Statistics	Mean	First decile Q10	Median Q50	Last decile Q90	Gini
Value 2002	12.55*** (0.230)	1.948*** (0.112)	8.935*** (0.219)	27.83*** (0.790)	0.476*** (0.00541)
Value en 2010	13.90*** (0.155)	2.085*** (0.0601)	9.785*** (0.129)	30.53*** (0.403)	0.481*** (0.00389)
Evolution 2002-2010	1.352*** (0.277)	0.136 (0.127)	0.850*** (0.254)	2.697*** (0.887)	0.00591 (0.00666)
Composition Effect					
Income	0.126 (0.0970)	0.142*** (0.0501)	0.137 (0.0950)	0.441 (0.319)	-0.00232 (0.00239)
Unit price	-0.283*** (0.0667)	-0.173*** (0.0431)	-0.253*** (0.0682)	-0.528*** (0.152)	0.00528*** (0.00130)
Schooling level	0.296** (0.140)	0.0415 (0.0663)	0.220* (0.132)	0.440 (0.471)	-0.000395 (0.00344)
Overall composition effect	-0.0207 (0.199)	0.00590 (0.0995)	-0.102 (0.183)	-0.0206 (0.593)	0.00304 (0.00453)
Structure Effect					
Income	0.785 (4.738)	-0.564 (2.309)	4.296 (4.435)	-15.68 (14.54)	-0.228* (0.119)
Unit price	-1.054** (0.474)	0.383 (0.374)	-1.285 (0.788)	-0.319 (1.873)	-0.0116 (0.0120)
Schooling level	0.577 (0.812)	0.00516 (0.390)	0.742 (0.741)	1.346 (2.486)	0.0105 (0.0206)
Overall structure effect	1.977*** (0.290)	0.281** (0.131)	1.258*** (0.262)	4.025*** (0.931)	0.00582 (0.00732)

***Significant at the 1%-level ** Significant at the 5%-level * Significance at the 10%-level, Standard errors in parentheses.

TABLE 6. DECOMPOSITION PROCESSED VEGETABLE

Statistics	Mean	First decile Q10	Median Q50	Last decile Q90	Gini
Value 2002	28.53*** (0.475)	5.550*** (0.275)	22.45*** (0.458)	59.53*** (1.226)	0.432*** (0.00562)
Value en 2010	29.10*** (0.242)	6.382*** (0.146)	22.96*** (0.241)	59.55*** (0.667)	0.416*** (0.00275)
Evolution 2002-2010	0.573 (0.533)	0.832*** (0.311)	0.507 (0.518)	0.0222 (1.396)	-0.0159** (0.00626)
Composition Effect					
Income	-0.109 (0.191)	0.242* (0.129)	-0.104 (0.190)	-0.731 (0.516)	-0.00570** (0.00248)
Unit price	-0.780*** (0.144)	-0.400*** (0.0889)	-0.800*** (0.143)	-1.107*** (0.224)	0.00618*** (0.00134)
Schooling level	0.296 (0.281)	0.651*** (0.178)	0.359 (0.275)	-0.174 (0.715)	-0.00834** (0.00355)
Overall composition effect	-1.366*** (0.424)	-0.157 (0.245)	-1.167*** (0.399)	-3.104*** (0.944)	-0.00215 (0.00475)
Structure Effect					
Income	10.13 (8.764)	1.545 (5.868)	10.43 (8.923)	14.96 (23.97)	0.0815 (0.111)
Unit price	4.474*** (1.148)	1.559 (1.534)	5.380** (2.537)	5.710 (4.549)	-0.0401*** (0.0146)
Schooling level	3.733** (1.472)	-0.221 (0.948)	2.695* (1.488)	9.360** (4.004)	0.00777 (0.0185)
Overall structure effect	2.113*** (0.529)	1.392*** (0.321)	1.937*** (0.529)	2.365 (1.493)	-0.0204*** (0.00657)

***Significant at the 1%-level ** Significant at the 5%-level * Significance at the 10%-level, Standard errors in parentheses.

6.2. Few changes in education-related inequalities

The estimated structure effects of education suggest that there has been a widening of education-related social inequalities between 2002 and 2010, but for the fresh fruits only. For this product category, the educational gradient in purchases is more positive in 2010 than in 2002, so that there are more differences in purchasing behaviours between the less and the more educated now than before. We note that this effect is not found for the purchases of fresh vegetable and processed F&V: the absolute differences between education groups have remained stable between 2002 and 2010. It is worth noting that there are no significant structure effects for income.

7. Discussion

Our results suggest that there has been a significant composition effect of unit prices. However, the unit prices are constructed as a ratio of purchased quantities on expenditures. Their variations only partially reflect changes in “true” prices. They differ between households according to their choices of quality, which in turn depend on household preferences for quality and on the quality offered on markets. While we observe a decrease in the unit prices of fresh F&V in the data, Section 4 has provided evidence that there has been an increase in the prices observed in shops over the period. Between 2005 and 2010, the price fresh F&V have increased by 1% per year. Hence, the fall in unit prices observed in our data reflect a decrease in the quality of household purchases.

We can interpret this decrease in unit prices as a change in household preferences for quality, even if the inclusion of socio-demographic variables is likely to capture some of these changes. As information campaigns put the emphasis on the quantity rather than on the quality of products, the consumers would tend to switch to products of lower quality in order to achieve the nutritional targets.

But strategic reactions on the supply side of the market may also explain this decrease in quality. When the supply is relatively rigid, the producers react to short-term increase in the demand for F&V by increasing real supply prices. The increase in unit prices is much less important as consumers switch to products of lower quality (Griffith et al, 2012). The demand for low-quality products increases and, in the long-term, the market forces fulfill their balancing role. Most retailers have indeed increased their importations from Southern European countries and some local producers have increased their productivity. However, there is evidence that this increase in supply has resulted in a decrease in the average quality offered in the market, through the development of soilless crops.

In this study, we have analyzed the evolution of social inequalities. According to structure effects, social inequalities between educated groups have increased for fresh fruits, but not for other product categories. This does not seem to hold for income. To check this point, we can measure income-related social inequalities through a concentration index. Ranking household by income level, we found that income-related inequalities have actually *decreased* between 2002 and 2010 (see the Table 7 below).

TABLE 7. CONCENTRATION INDEX, RANKING BY INCOME, 2002-2010

	Fresh fruits	Fresh vegetables	Processed fruits	Processed vegetables
2002	0.018	0.023	-0.014	-0.029
Std. Error	(0.003)	(0.003)	(0.006)	(0.003)
2010	0.012	0.009	-0.013	-0.019
Std. Error	(0.001)	(0.001)	(0.002)	(0.001)

The positive concentration index for fresh products reflects inequalities in favor of the most advantaged, which are lower in 2010. On the contrary, the negative concentration index for processed F&V traduce inequalities favoring the least advantaged.¹⁰

8. Conclusion

The consumption of F&V has become a major public health concern in France since more than a decade now. The 5-a-day slogan is ubiquitous – a success of the National Nutrition and Health Program implemented in 2001. We report a significant increase in F&V purchases between 2002 and 2010, although we cannot attribute this increase solely to the 5-a-day program. We highlight the importance of confounding factors, such as education and income. We also show the composition effect of unit prices especially for the “low” consumers of fresh F&V. This effect is likely to reflect a decrease in the quality of purchases: the NNHP may therefore have favoured a higher consumption of F&V, but also the consumption of products of lower quality. The potential unintended consequences in terms of exposure to pesticides should be investigated. Regarding inequalities, there has been a reduction of overall inequalities, and an increase in education-related inequalities for the fresh fruits only. Income-related inequalities have remained stable or decreased, which might be per se a success for the NNHP.

¹⁰ However, one must be cautious in using the term “advantage”, as processed F&V often contain added sugar and therefore have a lower nutritional value.

Bibliography

- Blinder, A. S. (1973) "Wage Discrimination: Reduced Form and Structural Variables", *Journal of Human Resources* 8: 436-455.
- Bertail, P., and F. Caillavet. (2008). "Fruit and Vegetable Consumption Patterns: A Segmentation Approach." *American Journal of Agricultural Economics* 90:827-842.
- C M Pollard, M R Millera, et al. (2008). "Increasing fruit and vegetable consumption: success of the Western Australian Go for 2&5 campaign." *Public Health Nutrition* 11(03): 314-320.
- Capacci, S., M. Mazzocchi, B. Shankar, J. Brambila Macias, W. Verbeke, et al, (2012) "Policies to Promote Healthy Eating in Europe: A Structured Review of Policies and their Effectiveness." *Nutrition Reviews* 70:188-200
- Capacci, S. and M. Mazzocchi (2011). "Five-a-day, a price to pay: An evaluation of the UK program impact accounting for market forces." *Journal of Health Economics* 30(1): 87-98.
- Capacci, S. et al. (2012) « The regional price of junk foods relative to healthy foods in the UK: indirect estimation of a time series, 1997-2009 » Contributed Paper prepared for presentation at the 86th Annual Conference of the Agricultural Economics Society, University of Warwick, United Kingdom
- Cox,TL. and MK Wohlgenant (1986) « Prices and Quality Effects in Cross-Sectional Demand Analysis » *American Journal of Agricultural Economics*, Vol. 68, No. 4. (pp. 908-919
- Darmon N., Briend A., Drewnowski A. (2004) « Energy-dense diets are associated with lower diet costs: a community study of French adults » *Public Health Nutrition* 7(01): 21-27.
- Darmon N., Ferguson E., Briend A. (2003). « Do economic constraints encourage the selection of energy dense diets? » *Appetite* 41(3): 315-322.
- Deaton,A. (1988). "Quality, Quantity, and Spatial Variation of Price" *American Economic Review* 78(1): 418-430
- Deaton, A. Dupriez, O. (2011) « Spatial price differences within large countries » Princeton University and World Bank
- Drewnowski, A et Specter SE (2004) « Poverty and obesity : the role of energy density and energy costs » *American Journal of Clinical Nutrition* ; 179 :6-16
- Etilé, F.(2013) "Education policies and health inequalities : Evidence from changes in the distribution of Body Mass Index in France, 1981-2003" *Eco. Hum. Biol.*
- Fortin, N., T. Lemieux, et al. (2011). "Decomposition Methods in Economics." 4: 1-102.
- Giskes,K., et al. (2007) "Socioeconomic inequalities in food purchasing: The contribution of respondent-perceived and actual (objectively measured) price and availability of foods" *Preventive Medicine*
- Griffith,R., L.Nesheim, et al (2012) "The impact of 5 a day" Papier présenté à ASSA meeting annuel Chicago
- Grossman, M. (1972) "On the concept of health capital and the demand for health" *The Journal of Political Economy*
- Grossman, M. (2000) "The human capital model" *Handbook of Health Economics*, Volume 1
- Hung HC, Joshipura KJ, Jiang R, et al. (2004) "Fruit and vegetable intake and risk of major chronic disease". *J Natl Cancer Inst*; 96:1577-84.

He FJ, Nowson CA, Lucas M, MacGregor GA. (2007) "Increased consumption of fruit and vegetables is related to a reduced risk of coronary heart disease: meta-analysis of cohort studies" J Hum Hypertens; 21:717-28.

Pearson, (2005) "Do food desert influence fruit and vegetable consumption? A cross sectional study" Appetite

Plessz, M., Gojard, S. (2010) « La consommation de légumes des ménages français : préparation domestique ou achats de produits transformés ». Aliss Working Pape

Pomerleau, J, Lock, K, et al. (2005). "Interventions Designed to Increase Adult Fruit and Vegetable Intake Can Be Effective: A Systematic Review of the Literature." The journal of nutrition, 135(10): 2486-2495.

Oaxaca, R. (1973). "Male-Female Wage Differentials in Urban Labor Markets" International Economic Review, 14: 693-709.

Variyam, Blaylock et al (1998) "USDA's Healthy Eating Index and Nutrition Information" Food and Rural Economics Division. Technical Bulletin No. 1866

D.Smith, (2010) "Neighbourhood food environment and aera deprivation : spatial accessibility to grocery stores selling fresh fruit and vegetables in urban and rural settings " International journal of epidemiology, 39 :277-284

Staudigel, (2010) "The Demand for Food Quality in Russia and its Linkage to Obesity » Selected Poster Paper, prepared for presentation at the 1st Joint EAAE/AAEA Seminar

Wagstaff,A., Van doorslaer E.,Watanabe, N., "On decomposing the cause of health sector inequalities with a application to malnutrition inequalities in Vietnam" Journal of Econometrics, 112(1): 207-223

E. Winkler et al « Does living in a disadvantaged area mean fewer opportunities to purchase fresh fruit and vegetables in the area? Findings from the Brisbane food study" Health and Place 12(3): 306-319

WHO/FAO (2003) "Diet Nutrition and the Prevention of Chronic Disease" World Health Organization

Institut National Recherche Agronomique (2007) « Les fruits et légumes dans l'alimentation : enjeux et déterminants de la Consommation » Rapport d'expertise scientifique collective

INCA (2009) « Étude Individuelle Nationale des Consommations Alimentaires 2 » Rapport INCA 2

Ministère de la santé et des solidarités (2006-2011, 2011-2015) "Programme national nutrition santé. Action et mesures "

Haut Conseil Santé Publique « Les inégalités sociales de santé : sortir de la fatalité » Décembre 2009