CONSEQUENCES OF THE 5-A-DAY CAMPAIGN:
EVIDENCE FROM FRENCH PANEL DATA

Andres Silva*

Fabrice Etilé*†

Gaelle Jamet*

*UR 1303 Food and Social Science Research Unit (ALISS)

The French National Institute for Agricultural Research (INRA)

65, Boulevard de Brandebourg

Ivry sur Seine 94205

Email: andres.silva@ivry.inra.fr

Email: fabrice.etile@ivry.inra.fr

Email: gaelle.jamet@ivry.inra.fr

Phone: +33(0)1 49 59 69 00

†Paris School of Economics (PSE)

48, boulevard Jourdan

75014 Paris, France

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CONSEQUENCES OF THE 5-A-DAY CAMPAIGN:
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(How does the 5-a-Day Campaign Impact Household Purchase Behavior?
An Ex-Post Evaluation using Household Panel Scanner Data)[1]

Andres Silva*
Fabrice Etilé*†
Gaelle Jamet*

Abstract

'5-a-day' public information campaigns have been implemented in many countries to promote the consumption of at least five portions of fruits and vegetables (F&Vs) per day per person as part of a healthy diet. This study proposes an ex-post evaluation of its impact on household purchases of F&Vs for food-at-home consumption, using household scanner panel data and a before-after identification framework. It uses a dynamic tobit panel data model to account for non-participation, habit formation and household unobserved heterogeneity. Over the 2002-2010 period, the portions of F&V available each day for consumption by a household member have increased from 2.4 to 3.3 (+0.9). Our estimates reveal that 43% of this increase is due to the 5-a-day campaign (+0.38 portions). The largest effect is observed for fresh fruits (+0.16 portions), processed vegetables (+0.08 portions) and natural fruit juices (+0.08 portions). As a negative nutritional consequence, there has also been a small increase in fruit drinks with added sugar (+0.05 portions).

Keywords: 5-a-day, information campaign, fruit and vegetables, dynamic tobit model

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[1] Corresponding author: Andres Silva (andres.silva@versailles.inra.fr); The authors thank Christine Boizot-Szantaï for data assistance. Financial support from the INRA Metaprogramme DID'IT – project FOODPOL is gratefully acknowledged.

1 Introduction

Public Health authorities are concerned about the increasing prevalence of food-related chronic diseases (diabetes, obesity, some cancers, etc.), which have been related to various nutritional and food behaviors, such as an increasing consumption of sugar-, fat- and salt-rich food, and an insufficient consumption of fruits and vegetables (Etilé, 2011, Hill, *et al.*, 2003, WHO/FAO, 2003). Public interventions to curb these trends often take the form of information campaigns targeting the whole population.[2] This research proposes an ex-post evaluation of the impact of the well-known "5-a-day" public information campaign, on the purchase behaviors of French households.

The 5-a-day campaign promotes the consumption of at least five portions of fruits and vegetables (F&Vs) per day per person as part of a healthy diet. It was originally designed by the California Department of Health in late 1980s, and then implemented in other states in the United States (US). In 1992, the state of Victoria (Australia) implemented a version of the 5-a-day campaign. At the beginning of the last decade, the campaign expanded to the United Kingdom (UK), France and many other countries. Today, more than twenty-five countries around the world have implemented versions of the 5-a-day campaign.[3] Therefore, this study can help inform future campaign efforts, and contribute to international comparisons and peer-learning experiences between countries.

Although the 5-a-day campaign is popular around the world, its behavioral impact has not yet been well-documented. A remarkable exception is Capacci and Mazzochi (2011), who evaluate the impact of the 5-a-day campaign on the food purchase behavior of UK households between 2002 and 2006. They exploit different cross-sections of the Expenditure and Food Survey to identify the change in purchased quantities net of the price effects and other observed confounders of the policy impact. We extend their evaluation framework to identify the consequences of the 5-a-day campaign in France. Exploiting the high-frequency of our dataset and its panel dimension, we implement a dynamic fixed-effect tobit panel data model, which

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[2] A recent survey reveals that, out 121 public policies to promote healthier eating in Europe, 38 of these corresponded to informational campaigns, 31 corresponded to nutritional education to children at school and 13 corresponded to school meal regulations, including vending machines and provision of free fruit and vegetables according to Capacci, S., M. Mazzocchi, B. Shankar, J. Brambila Macias, W. Verbeke, F.J.A. Pérez-Cueto, A. Kozioł-Kozakowska, B. Piórecka, B. Niedzwiedzka, D. D'Addesa, A. Saba, A. Turrini, J. Aschemann-Witzel, T. Bech-Larsen, M. Strand, L. Smillie, J. Wills, and W.B. Traill. 2012. "Policies to Promote Healthy Eating in Europe: A Structured Review of Policies and their Effectiveness." *Nutrition Reviews* 70:188-200.

[3] For instance, Australia implemented the campaign "Go for 2&5", which states that people should eat at least two portions of fruits and five portions of vegetables per day.

allows us to take into account censored (at zero) consumption in a similar before-after evaluation framework, while controlling for habit formation, variations in a number of observed household characteristics and household unobserved heterogeneity. Finally, while Capacci and Mazzochi (2011) aggregate food consumption into fruits, vegetables and other foods, we work separately with fresh fruits; fresh vegetables (excluding tubers & potatoes); processed fruits; processed vegetables (excluding tubers & potatoes); tubers & potatoes; fruit drinks (some content of natural fruit juice plus added sugar) and natural fruit juices (100% fruit juices with no-added sugar). Doing this, we are able to identify the intended impact of the 5-a-day campaign on the F&V groups that were targeted by the campaign (fresh and processed fruits and vegetables, and natural juices), but also its unintended effects on the purchases of close potential substitutes (tubers & potatoes, and fruit drinks). In the rest of the paper, the abbreviation F&V designates all targeted food groups.

France has experienced three phases of public information about F&V consumption, in 2003, 2007 and 2008, with different types of actions. Only the 2007 and 2008 phases explicitly promoted the "5-a-day" concept. The latter was already present in the first National Nutrition and Health Program (PNNS), which was implemented in 2001. The '5-a-day' recommendation was one of the nine nutritional recommendations promoted by this program. Although it was not explicitly present in the 2003 public information campaign, this recommendation was diffused through a guide (published in 2001) and actions towards health professionals. We thus consider for simplicity that the 2003 public information campaign implicitly promoted the '5-a-day' recommendation. We document the specific impact of each phase, and also assess the overall policy impact of the campaign. The raw statistics show that purchases, in terms of daily portions available for food-at-home consumption for each household member, have increased by 0.88 units between 2002 and 2010 (one unitary portion is equivalent to 80 grams of F&V or 150 milliliters of natural fruit juice). Over the period, the overall policy effect corresponds to an increase of +0.38 portions of F&V (43.2% of the total increase), which is mainly due to fresh fruits (+0.16 portions), but also includes a +0.08 portion increase in natural fruit juice. The information campaigns also increased the purchases of tubers & potatoes (+0.03 portions) and, perhaps as a negative nutritional consequence, has caused a +0.05 portion increase in fruit drinks intakes, which can be high in added sugar. The first phase of the campaign, which was based on posters displayed in public places, newspaper and radio ads, has had a lower impact on total F&V purchases, perhaps because it did not mention explicitly the *quantitative* "5-a-day" concept. It actually caused significant substitutions among F&V groups: people increased their purchases of some F&V groups mainly at the expense of fresh vegetables. Adding TV programs, TV ads, and online ads, as done in the second and third phases of the campaign, and making the recommendation more explicit with a focus on quantities, appears to be more effective, although it is arguably costlier.

The remainder of the article is organized as follows. Section 2 starts by describing the evolution of F&V purchase behaviors in France. It provides the general context of the 5-a-day campaign. Section 3 develops the methodology and the empirical model. Section 4 presents the data. Section 5 displays and discusses the empirical results, and finally, Section 6 summarizes the findings and the policy relevance of the research.

2 Fruits, vegetables and public health policies in France

2.1 Trends in fruit and vegetable purchase behaviors in France

This section uses the TNS-KantarWorldPanel (TNS-KWP) home scanner dataset to describe the trends in household purchases of F&V. The same dataset will be used in the empirical analysis. The TNS-KWP panel is a 4-year rotating panel of households, which are selected by stratification according to socioeconomic variables to make up a representative sample of the French population. Around five thousand households are observed between January 2002 and December 2010. All households are asked to keep track of *every* food purchase for home consumption. They provide details of the quantity and expenditure for each purchase. For this study, purchases were aggregated at a monthly level for each household. In addition, demographic information, such as household income, the region of residence, the gender of the food shopper, the household composition and the age of each household member, is collected each year.

The TNS-KWP Kantar home scanner dataset provides *purchase* data. It does not provide information about how food is actually consumed, which may alter its nutritional content. For instance, we are not able to distinguish whether the vegetables were consumed fresh or fried. This dataset also does not provide information with respect to non-consumable pieces and perishability. Fresh F&Vs, more than processed ones, contain pieces that are not edible or can spoil. Last, we observe only purchases for food at home. People also eat F&Vs away from home. As a result, the total quantity of F&Vs that is registered in the dataset represents an upper limit of actual F&V intake at home, which is itself lower than actual total F&V intake. Being aware of these limitations, food-at-home expenditure is a relevant outcome for policy evaluation, especially in France where food-away is much less developed than in Anglo-Saxon countries.[4]

[4] According to the French Household Budget Survey 2006, about 23% of the total food budget and less than 15% for the less well-off households is spent on food-away. The food intake INCA 2006-2007 survey reveals that 73.7% of lunches and 86.9% of dinners are eaten at home. Note that take-away meals that are consumed at home are in the data, but we ignore them in the analysis (as well as all ready-meals containing some vegetables) since they are not included in the perimeter of the policy objective: they also contain a lot of added sugar, salt and fat.

In addition, one clear benefit of the data is that they provide accurate and exhaustive information about household purchase behaviors.[5]

Public policies describe F&V intake in terms of portions. A F&V portion is defined as 80 grams of fruits and/or vegetables or 150 milliliters of natural fruit juice (100% fruit juices and no sugar added). "5-a-day" means eating five portions per day, which corresponds to 400 grams. No difference is made (at least in France) between adults and children, men and women, etc. By analogy, we have derived F&V portions *per capita* per day from the purchase data: they are computed as the total quantity in kilograms of fruit and vegetable purchased per household per month divided by the number of household members and the kilogram-to-portion conversion factor (80 grams/portion or 150 milliliters of natural fruit juice). These portions are a crude measure of the F&Vs that are available daily for individual consumption at home.

Table 1 below shows the proportion of the individual population for which one portion or less of F&Vs is available, the proportion of the population for which at least five portions of F&Vs are available, and the average portions of F&Vs available. In 2002, the *per capita* F&V availability was 2.38 portions per day, which increased to 3.26 portions in 2010. In 2002, at least 37% of people consumed less than a portion of F&Vs at home each day. On a positive note, this number dropped to 27% in 2010. Similarly, the proportion of people for which at least 5 portions were available rose from 7% to 14%.

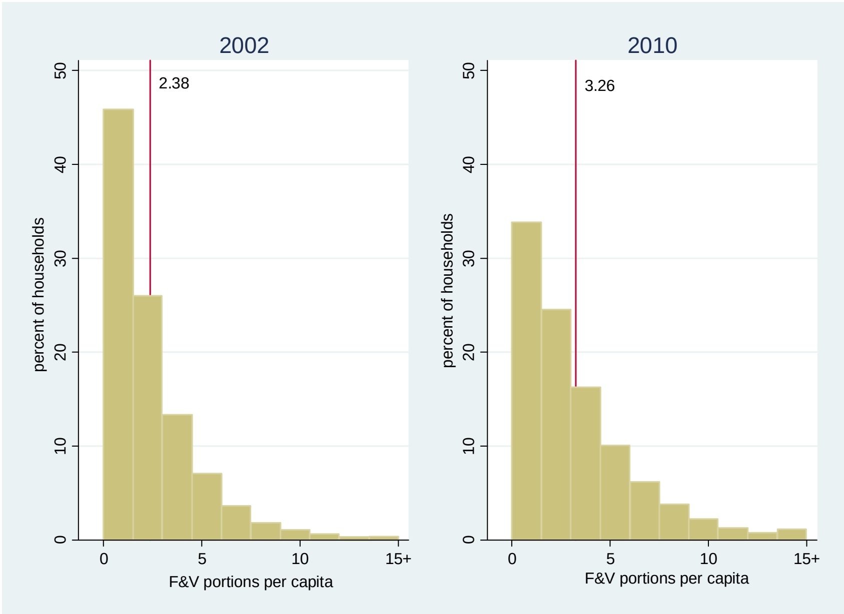
TABLE 1. *PER CAPITA* F&V PORTIONS AVAILABLE PER DAY

year	share less than 1 a day	share more than 5 a day	mean of F&V portions
2002	37%	7%	2.38
2003	34%	8%	2.53
2004	36%	9%	2.54
2005	32%	10%	2.77
2006	33%	10%	2.73
2007	33%	10%	2.72
2008	30%	12%	2.95
2009	29%	13%	3.05
2010	27%	14%	3.26

Source: Our processing using TNS-KWP Kantar home scanner dataset (2002-2010). According to *le Programme National Nutrition Santé* (*PNNS*), a F&V portion corresponds to 80 grams of fruit and/or vegetables or 150 milliliters of natural fruit juice. Our estimation is based on purchase data for food-at-home, and thus includes non-consumable F&V pieces and excludes food-away purchases. Using the survey representative weights, the purchased quantity per month per household is divided by thirty (days) and by the number of people in the household. The first column shows the percentage of people for which one portion or less of F&Vs is available each day for at-home consumption. The second column shows the percentage of people for which at least five portions of F&Vs are available. The third column corresponds to the mean number of F&V portions a day per person.

[5] All datasets available for demand studies have specific limitations. For instance, actual food intake data is expensive to obtain, difficult to analyze (due to large variability in the preparation conditions). They are typically collected on small cross-sections of individuals (at least in France) and the economic variables are absent or of poor quality.

FIGURE 1. CHANGES IN THE DISTRIBUTION OF AVAILABLE F&V PORTIONS, 2002-2010



Source: Our processing using TNS-KWP Kantar home scanner dataset (2002-2010). The histogram on the left (right) corresponds to the distribution of the F&V portions available per day *per capita* for food-at-home consumption in 2002 (2010). The auxiliary red lines correspond to the average number of portions that specific year.

Consistent with Table 1, Figure 1 shows the distribution of F&V purchases in terms of portions. In almost a decade, the distribution moved to have a fatter right tail, which suggests that people consumed more F&Vs in 2010 than in 2002. Although the trends by food group are not shown in detail here, it is worth noting that part of the increase is due to natural fruit juices. In 2002, individuals drank the equivalent of 0.27 portions of F&Vs through natural fruit juices. In 2010, people drank the equivalent of 0.47 portions of F&Vs. Therefore, 0.20 portions (natural juices increase) out of 0.88 portions (the overall F&V increase, 3.26-2.38=0.88) can be attributed to the increase in natural juice purchases.

Table 2 shows the number of distinct varieties of F&V items (apple, banana, lettuce, etc.) that were purchased each month, the proportion of households that purchased at least five different items of F&V per month, and the average monthly expenditure on F&Vs per individual in the household. In 2002, 11.00 different F&V items were purchased on average each month, and 11.38 items in 2010. In addition, 28.57% of households purchased at least five different items of F&Vs per month, a proportion that increased to 33.59% in 2010. Finally, the average total F&V expenditure per household member increased from 14.56 euros in 2002 to 18.67 in 2010.

TABLE 2. F&V PURCHASE DECISIONS AND *PER CAPITA* EXPENDITURES

year	F&V items per month	share at least 5 a month	F&V expenditure (euros)
2002	11.00	28.57%	14.56
2003	11.19	29.33%	15.46
2004	11.11	29.73%	14.80
2005	11.35	31.33%	15.89
2006	11.09	31.14%	15.77
2007	11.04	31.00%	15.65
2008	11.52	32.78%	16.80
2009	11.50	34.36%	16.99
2010	11.38	33.59%	18.67

Source: Our processing using TNS-KWP Kantar home scanner dataset (2002-2010). Using the survey representative weights, the monthly household expenditures on F&Vs and the number of distinct F&V items are divided by thirty, and for expenditures by the number of household members.

Over the period, the *per capita* F&V expenditures increased by 28%, which corresponds to a 37% increase in the number of F&V portions available for food-at-home. These numbers suggest that consumption and expenditures have increased substantially, but the number of varieties remained stable: people tend to eat more of the same number of F&Vs.

2.2 F&V information campaigns in France

Economists have been and are still interested by the effectiveness of taxes, subsidies and information as public interventions to reduce the prevalence of food-related chronic diseases, especially obesity (Etilé, 2011). In the case of F&Vs, information is the most common policy intervention, followed by subsidies. Information policies in France have been mainly based on health education and public information campaigns, and since 2007 some advertising regulations. The "5-a-day" public information campaign aims at increasing consumer awareness about the benefits of healthy behaviors and at promoting healthier eating. Although this latter aspect may be perceived as a normative injunction to behave healthily, subsidizing the diffusion of generic nutritional information is arguably justified from a consumer welfare perspective. Individuals often do not fully understand the short and long-term health consequences of their food choices, while the maximization of consumer welfare requires that consumers be perfectly informed about these choices. As households are likely to make suboptimal choices, information campaigns provide them with easy-to-understand messages. Most firms have few incentives to provide such generic information to consumers, as it may benefit competitors. Hence, subsidizing this type of information may enhance social welfare. Note however that the professional union of French F&V producers has also contributed to the promotion of the "5-a-day" concept through the period, as well as some retailers. The role of these potential confounders/complementary actions is discussed in Sections 4 and 5.

TABLE 3.THE 5-A-DAY CAMPAIGN ACTIONS IN FRANCE

phase	period	actions
A	jun-03	posters, radio and newspaper advertizing
B	oct-nov-07	TV program of 40 episodes (weeksday evenings)
C	jun-08	two types of TV spots, web banners advertizing, posters and press advertising (in newspapers and as separate pamphlet)

Source: INPES, Institut National de Prévention et d'Education pour la Santé

Table 3 summarizes the three phases of F&V public information campaigns implemented in France over the last decade. In June 2003, a visual campaign using advertising in public places was carried out to highlight the importance of eating any type of fruit (fresh, frozen or canned) without explicitly mentioning the 5-a-day concept yet. This was completed by ads on radio and in newspapers. Secondly, from October to November 2007, a special TV program consisting of forty episodes was broadcasted on national TV. Each episode broadcasted a different topic about achieving a healthy lifestyle. The concept of eating five portions of F&Vs was for the first time explicitly mentioned. Finally, in June 2008 a multimedia campaign was implemented. It involved two types of TV spots, web banner advertising, newspaper advertising, and the distribution of more than 1.5 million pamphlets through the National health services and a local newspaper in Paris. Once again, the "5-a-day" concept was abundantly publicized. It is worth noting that the "5-a-day" concept has appeared in the first PNNS, in 2001, and in a guide that was edited in 2001 and cost two euros in newspaper kiosks. As such, we consider that the phase A of the campaign is an element of the whole "5-a-day" public information campaign, although the edition of the guide and the other actions based on relays (health professionals, distributions of F&Vs at school, etc.) were not strictly speaking part of the public information campaign. Once again, we discuss the role of these confounders complementary actions in Sections 4 and 5.

The 5-a-day campaign was originally designed in the US. Then, Australia, the UK, France and over twenty other countries implemented their own versions of the campaign. Most information campaigns, as is the case for the 5-a-day, have been evaluated in terms of change on public awareness and knowledge. For instance, in the US, Birmingham, *et al.* (2004) found that, after receiving F&V information taking the form of a 5-a-day recipe booklet, mothers from low-income families were more willing to include F&Vs in the family diet. In Australia, between 1992 and 1995, the state of Victoria ran a television advertising campaign to increase the level of awareness with respect to the consumption of F&Vs under the message "2 Fruit `n' 5 Veg Every Day". Dixon, *et al.* (1998) conducted a telephone survey taking five hundred people into account, and found an increase of awareness which was correlated to the media investment. At the end, the authors suggested that the campaign may need to be repeated over time to maintain the level of awareness.

To the best of our knowledge, there is only one study that evaluates the impact of changes on nutritional intake and health indicators, which is surprising given the popularity of the campaign around the world. Capacci and Mazzochi (2011), using the Expenditure and Food Survey in the UK from 2002 to 2006, evaluated the impact of the 5-a-day campaign on F&V consumption. They use a quadratic AIDS demand system to better control for changes in the pattern of prices in a before vs. after identification framework. Controlling for the market dynamics (real price variations) is all the more important because an increase in demand directly caused by the campaign may induce an increase in supply price, with an indirect negative impact on purchases. They find that the 5-a-day campaign led to an average increase of +0.3 portions, which varies between +0.2 and +0.7 across different income quartiles, with the lowest quartile experiencing the largest policy impact, thus helping to reduce inequalities. We use their modeling framework as a starting point in the current study, which is the first effort to evaluate the F&V information campaign in France, with a special emphasis on the "5-a-day" campaign. Section 3 hereafter shows how we extend the empirical methodology to account for several key features of household purchase behaviors, while Section 4 will present the data in more details.

3 Methodology

3.1 A before-after evaluation framework

Considering an information campaign as a treatment, we are *a priori* interested in estimating the average treatment effect (ATE), which is the difference in food consumption levels between a control and a treated group. Let D_i be a binary variable indicating whether the household h is treated ($D_h=1$) or not ($D_h=0$). Let y_{h1} be the outcome if the household is treated and y_{h0} the outcome if it is not treated. In an experimental setting, assuming that subjects are randomly assigned to each group and assuming no selection bias, the outcome difference between the control and treated group can be associated with an information campaign.

$$\Delta_{ATE} = E(Y_{\mathrm{h1}}|D_h = 1) - E(Y_{\mathrm{h0}}|D_h = 0)$$

Yet, in a national information campaign, all people are exposed to the treatment. There is no possibility of defining a control group. This has two important consequences. First, we can only identify an average treatment effect on the treated (ATT). Second, we must necessarily rely on a before-after identification procedure, which yield unbiased estimates of policy effect only if we are able to control for the various events that are not part of the information campaigns but could affect the outcome. Let t be the monthly time index. The ATT is the outcome difference between the treated subjects (the whole population) after the information campaign and the treated subjects had they not been exposed to the campaign.

$$\Delta_{ATT} = E(Y_{\text{ht1}}|D_{ht} = 1) - E(Y_{\text{ht0}}|D_{ht} = 1)$$

Suppose that purchases y_{ht} are modeled as a function of D_{it} and a set of other control variables X_{ht} as:

$$Y_{ht} = \alpha D_{ht} + \beta X_{\text{ht}} + \vartheta_{ht} \qquad \textbf{(1)}$$

where ϑ_{ht} is an error term. Suppose that the campaign occurs at time t_0, then D_{ht} is merely a time binary variable taking the value 1 if $t \geq t_0$ and 0 otherwise. Then, the counterfactual outcomes y_{ht0} is simply obtained by setting D_{ht} to 0 in equation **(1)** for $t \geq t_0$ and:

$$\Delta_{ATT} = E(\alpha + \beta X_{\text{ht}} + \vartheta_{ht}|t \geq t_0) - E(\beta X_{\text{ht}} + \vartheta_{ht}|t \geq t_0) = \alpha$$

Clearly, if we do not control for events that may affect the outcome, the estimates of α will be biased. Likewise, the estimated ATT will be biased if the model for the outcome Y_{ht} is misspecified. Section 4 will show how we control for a number of observable events that may affect household purchase behaviors: variations in prices, income, social and demographic characteristics, media news about the campaign, seasons and years. The rest of this Section proposes an empirical model that extends specification **(1)** to take into account several key aspects of consumer behaviors: the high frequency of zeros in the purchase data, habit formation (state dependence) and unobserved fixed heterogeneity.

3.2 Empirical model

To evaluate more accurately the impact of the information campaign, changes in purchase behaviors will be separately analyzed for the following food groups: fresh fruits; fresh vegetables (excluding tubers & potatoes); processed fruits; processed vegetables (excluding tubers & potatoes); natural fruit juices (without added sugar); tubers & potatoes; and fruit drinks (which contain added sugars). The distinction between these seven food groups is important for policy purposes. Fresh fruits, fresh vegetables, processed fruits, processed vegetables and natural fruit juices are the products targeted by the 5-a-day public information campaign. Natural fruit juices in particular seem to have an increasing importance in the household shopping cart. They include natural smoothie juices, which are also 100% fruit juices with no added sugar. In contrast, the 5-a-day campaign is not concerned with the consumption of tubers & potatoes, nor with the consumption of fruit drinks, as they contain added sugar. Household purchases are aggregated at a monthly level, which yields a relevant percentage of zeros: 15% percent on average. The censored nature of the data should be taken into account in the empirical specification. Habit persistence, which is a key aspect of food choices, must also be considered because past consumption decisions are likely to influence current decisions.[6] Last, consumption decisions may be affected by fixed unobserved characteristics. We take into account these three key aspects of household behaviors by using dynamic tobit models.

To model censoring at zero, replace in specification **(1)**, the observed consumption by a latent variable Y^{*}_{ht}, which is linked to Y_{it} through the following selection rules:

$$Y_{ht} = \begin{cases} 0 \; if \; Y^{*}_{ht} \leq 0 \\ Y^{*}_{ht} \; if \; Y^{*}_{ht} > 0 \end{cases} \quad \textbf{(2)}$$

with $Y^{*}_{ht} = \alpha D_{ht} + \beta X_{\mathrm{ht}} + \vartheta_{ht}$

Then, we specify the error term ϑ_{ht} as the sum of a household fixed effect, μ_h, which captures the unobservable heterogeneity and is time independent, and a component η_{ht}, which is independently and identically normally distributed over time and across households. We eventually model habit persistence by adding lagged purchases on the left-hand side of the equation:

$$Y^{*}_{ht} = \alpha D_{ht} + \rho Y_{h,t-1} + \beta X_{\mathrm{ht}} + \mu_h + \eta_{ht} \quad \textbf{(3)}$$

Equations **(2**) and **(3**) define a dynamic fixed-effect tobit model. In this model, lagged purchases are correlated with the fixed effect. When we model jointly purchase decisions at time *t=1,…T*, this leads to inconsistent parameter estimates, as there is an initial condition problem: purchases at time *t=0* cannot be modeled but are still correlated with the fixed effect (Heckman, 1987). Following Wooldridge (2005), we solve this issue by conditioning the distribution of μ_h on initial purchases, Y_{h0}, and the average of the other variables in this way:

$$\mu_h = \gamma_1 Y_{i0} + \gamma_1 X_{h.} + \gamma_2 D_{h.} + \varepsilon_h \quad \textbf{(4)}$$

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[6] Capacci and Mazzochi (2011) already noted that panel data can help to disentangle the effect of habit persistence, but their data did not enable the authors to do so, as households surveyed in the UK Living Cost and Food Survey are not followed over time.

where $X_{h.}$ and $D_{h.}$ are the average of X_{ht} and D_{ht} over all periods, and ε_h is a household random effect that is uncorrelated with the other variables. The latent variable model in **(3)** becomes:

$$Y_{ht}^{*} = \alpha D_{ht} + \rho Y_{h,t-1} + \beta X_{\mathrm{ht}} + \gamma_1 Y_{i0} + \gamma_1 X_{h.} + \gamma_2 D_{h.} + \varepsilon_h + \eta_{ht} \qquad \textbf{(5)}$$

The model is estimated via maximum likelihood, assuming that the random effect is also normally distributed.[7]

4 Data and implementation

As mentioned in Section 2, the model is estimated using household scanner data from the TNS-KWP survey. The key challenge of any before-after evaluation procedure is to control for all events that may affect the outcome but are likely to be unrelated to the policy. This section presents the dependent variables, the policy variables of interest and shows how we control for the main confounders of these variables: price changes.

4.1 Quantities

The TNS-KWP panel provides for all purchase decisions, quantities and expenditures. Table 4 presents some statistics. As a monthly average, a French household purchase 16.91 kilograms of 'solid' F&Vs (total of fresh and processed), 1.6 liters of natural fruit juice, 2.2 kilograms of potatoes and 3.7 liters of fruit drinks. Out of the 16.91 kilograms of 'solid' F&Vs, 47.90% corresponds to fruits (fresh or processed) and 77.55% corresponds to fresh F&Vs. There are a few large values, which are displaced several standard deviations from the mean. Most of these extreme values per household are associated with large families. As such, we control for household size in the regressions.

[7] We use the command xttobit in Stata 12.

TABLE 4. PURCHASED QUANTITIES AND UNIT VALUES

Quantity (kgs/month)	mean	SD	min	max
fresh fruits	7.0	7.8	0	95.0
fresh vegetables	6.2	6.6	0	80.6
processed fruits	1.1	1.6	0	31.0
processed vegetables	2.7	3.0	0	49.9
potatoes	2.2	3.9	0	82.0
juices	1.6	3.2	0	67.2
fruit drinks	3.7	6.5	0	92.0

Unit value (euro/kg)	mean	SD	min	max
fresh fruits	1.5	0.2	1.1	2.1
fresh vegetables	1.7	0.2	1.4	2.0
processed fruits	2.9	0.2	2.7	3.6
processed vegetables	2.6	0.1	2.3	3.1
potatoes	1.0	0.2	0.7	1.4
juices	1.2	0.02	1.1	1.3
fruit drinks	0.7	0.04	0.7	0.8

1 euro = 1.31 US Dollar (April, 29th 2013), 1kg = 2.2046 pounds

The F&V purchased quantity series plots (available upon request) reveal a clear and expected seasonal pattern across the year and an unclear long term trend. Fresh and processed fruits have a contra-cyclical pattern (the highest point of one series corresponds to the lowest point of the other series). The same phenomenon is observed for fresh and processed vegetables. In contrast, the natural fruit juice series does show a clear increasing pattern and an unclear seasonality over the year, which is consistent with its increasing popularity. We control these seasonal effects and long-term trends by including binary variables for months and years in the regressions.

4.2 Policy variables

Hornik and Yanovitzky (2003) stated that some interventions may take time to show a significant impact. To match the evaluation design with the theory of the information campaign, we use the information provided in Table 3 to create a binary variable for each of the three phases of the campaign (A, B and C) taking value "one" after the phase and "zero" before. For instance, in the case of phase A that was implemented in June 2003, a binary variable was created that has the value of "zero" until May 2003 and "one" from June 2003 onward.

Information campaigns may have a direct effect on purchase behaviors, but also indirect effects that flow through changes in media awareness and various type of social interactions (social learning, peer effects, social norms). In some regressions, we control for changes in media awareness by using the numbers of articles on a health-related topic as a proxy of health information (Chern, *et al.*, 1995).[8] We assume that the number of articles is exogenous to consumption, although this is debatable as media awareness may be driven by public interest and financial support from the government or the industry (Zhao, *et al.*, 2013). In our study, the number of articles about F&Vs may be correlated with informational campaign events. In addition, the "5-a-day" concept has flown through field interventions of health professionals (at school, in community health centers) and through the diffusion of an eating guide in 2001. Although we partially net out these effects by introducing year binary variables in the regressions, one may conservatively consider the policy impact estimates as an upper limit of the true treatment effects.

4.3 Prices

The TNS-KWP dataset provides expenditure and quantity data. A standard procedure is to divide expenditure by quantity to obtain unit values, which are often assumed to be an adequate price proxy. As shown in Table 4, the average unit value of processed F&Vs is almost twice the average unit value of fresh F&Vs. As expected, natural fruit juices are more expensive than fruit drinks. However, unit values contain price and quality informational of consumer choices (Deaton, 1988). The quality component can be relevant for highly differentiated products, as it is the case here. Given that a consumer chooses price and quality simultaneously, while prices are exogenous, unit values are endogenous. If a unit value rises by one percent from one period to the following one, it is not possible *a priori* to know whether the consumer had chosen a product of a higher quality than before or whether the consumer had chosen the same quality and the market price was higher than before. As a result, assuming unit values are real prices produces an overestimation of actual price responses (Deaton, 1988). In addition, it will bias the estimate of the policy effect, if the campaign has also an impact on quality choices.

[8] Some examples can be found in the work done by Brown, D.J., and L.F. Schrader. 1990. "Cholesterol Information and Shell Egg Consumption." *American Journal of Agricultural Economics* 72:548-555. Also, Rickertsen, K., D. Kristofersson, and S. Lothe. 2003. "Effects of Health Information on Nordic Meat and Fish Demand." *Empirical Economics* 28: 249-273. We build an index of the number of times that the words the keywords *cinq fruits et légumes* and *5 fruits et légumes* (both mean "five fruits and vegetables" in French) appears in any article title in Le Figaro, Le Monde and Liberation. These are of the most popular nationwide newspapers in France, which together cover most of the political spectrum. We estimate a geometric weighted average of the previous twelve months. The geometric weight structure recognizes that subjects remember recent articles better than they remember older articles. We use this newspaper index as a proxy for previous beliefs/awareness of the 5-a-day campaign. Since we do not consider the news during the current month, we minimize the chances of correlation between the number of articles and the informational campaign.

To adjust unit values for quality effects, we use the procedure developed by Crawford, *et al.* (2003)[9], in which, clusters of residence are defined as specific area (e.g. region) in a point in time (e.g. month). Each household lives and shops for food in its cluster of residence. All the households that live in the same cluster face the same set of market prices (the law of "one price"). Therefore, in a specific cluster, differences in unit values can be attributed to differences in quality. The unit values are expressed in the following way:

$$lnv_{Ght} = \ln\pi_{Ght} + \beta_G lnx_{ht} + \gamma_G z_{ht} + \theta_G lny_{Gt} + u_{Ght} \quad \textbf{(6)}$$

where the natural logarithm of the unit value *v* of the household *h* of expenditure group *G* for the *h*-th households at time *t* is a function of quality, price and the total quantity that has been purchased by the household. The latter has an impact on unit values because of the quality-quantity trade-off faced by households. Quality choices thus depend on demographic characteristics *z*, household income *x*, the price π (which is unobserved), the purchased quantity y and a normally distributed error term u_{Ght} with mean 0. As all households in a cluster face the same market price, we can apply a within-cluster transformation (omitting the time subscript for simplicity) to get:

$$(lnv_{Gh} - lnv_G^C) = \beta_G(lnx_h - lnx^C) + \sum_l^L \gamma_G(z_{lh} - z_l^C) + \theta_G(lny_G - lny_G^C) + u_{Gh} - u_G^C \quad \textbf{(7)}$$

In the computation of the cluster values, we use the mean per cluster without taking into account the current observation. We estimate the above equation using two-stage least squared to address the endogeneity of the difference between the household log-quantity *y* and its cluster mean, by instrumenting it as in Crawford et al. (2003). Using the previous parameters, we calculate adjusted unit values, which are treated as exogenous prices (in natural log) and used in the estimation of our set of dynamic tobit models:

$$\hat{p}_{hG}^C = lnv_{Ght} - \hat{\hat{\beta}}_G lnx_{ht} - \hat{\gamma}_G z_{ht} - \hat{\hat{\theta}}_G lny_{Gt} \quad \textbf{(8)}$$

In our study, we conduct the procedure described above to generate an adjusted unit price series for each of the seven food groups. These adjusted unit values are considered as exogenous prices, and then included in the dynamic tobit estimation. They are also deflated by the Consumer Price Index.

[9] Some applications can be found in the work done by 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* 30:87-98. and Shankar, B., J. Brambila-Macias, B. Traill, M. Mazzocchi, and S. Capacci. 2013. "An Evaluation of the UK Food Standards Agency's Salt Campaign." *Health Economics* 22:243-250..

4.4 Other control variables

In term of demographics, we take into account a number of household characteristics, including age and gender of the food shopper[10], income, and type of occupation, which serve as control variables for differences in tastes and expenditures on F&Vs between households. We also control for household size, as larger households are likely to purchase larger quantities.

5 Main results

For each food group, three models were estimated: Model 1 (Table 5) controls for seasonal effects (using monthly binary variables), yearly effects (using annual binary variables), price, income and policy actions. Model 2 (Table 6), in addition to the variables in Model 1, also controls for habit formation (lagged dependent variable) and interaction between the lagged dependent variable and binary policy variables. Finally, Model 3 (Table 7), in addition to the variables in Model 2, also includes the geometrical mean of the number of newspaper articles in the last twelve months, to test whether some of the policy effects go through an increase in media awareness.

5.1 The impact of the "5-a-day" campaign

According to Model 1, each phase of the campaign leads to different reactions across food groups. Some phases increase the quantity purchased of specific F&V groups, while others decrease the quantity purchased. In contrast, Model 2 shows an increase in purchased quantities for almost all targeted F&V groups and all phases. It includes a lag of the dependent variable, which always has a positive and significant effect showing the importance of accounting for habit formation. The interaction effects of policy and previous consumption level are mostly negative in estimates of Model 2. This suggests that the 5-a-day campaign tends to decrease inequalities. Households with low consumption of F&Vs tend to increase their F&V consumption in a larger proportion than households with a large consumption of F&Vs. Surprisingly, this reduction in inequalities is not limited to F&V and natural fruit juices groups, but also can occur in the case of potatoes and fruit drinks. Introducing the news index in Model 3 do not affect the results, so that we hereafter focus on Model 2's results.

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[10] Controlling for gender effect is important as women are generally found to eat more F&V than men (see for instance Ashfield-Watt, P.A., A.A. Welch, N.E. Day, and S.A. Bingham. 2004. "Is 'Five-a-Day' an Effective Way of Increasing Fruit and Vegetable Intakes?" *Public Health Nutrition* 7:257-261.)

TABLE 5. MODEL 1 DYNAMIC TOBIT MODEL PER FOOD GROUP

MODEL 1	q fresh fruits		q fresh vegetables		q processed fruits		q processed veg		q potatoes		q natural juices		q fruit drinks	
	coefficient	SE	coefficient	SE	coefficient	SE	coefficient	SE	coefficient	SE	coefficient	SE	coefficient	SE
policy variables														
campaign A	**0.25**	0.08	**-0.48**	0.06	**0.06**	0.02	**0.06**	0.03	**-0.14**	0.06	0.04	0.07	0.10	0.09
campaign B	**-0.65**	0.07	**-0.44**	0.06	**-0.19**	0.02	**-0.21**	0.03	**-0.27**	0.06	**-0.16**	0.06	**-0.44**	0.09
campaign C	0.08	0.04	**-0.23**	0.04	**0.04**	0.01	-0.03	0.02	0.04	0.04	**-0.08**	0.04	**-0.40**	0.06
price index														
fresh fruits	**-0.09**	0.04	-0.07	0.04	0.02	0.01	-0.03	0.02	-0.04	0.04	-0.05	0.04	-0.02	0.06
fresh veg	**-0.10**	0.03	**-0.11**	0.02	-0.01	0.01	0.01	0.01	-0.02	0.02	-0.008	0.02	-0.01	0.03
proc fruits	-0.002	0.02	0.02	0.02	-0.01	0.01	0.002	0.01	0.03	0.01	0.003	0.02	-0.01	0.02
proc veg	-0.002	0.01	-0.01	0.01	-0.002	0.002	-0.002	0.003	**-0.02**	0.01	0.00	0.01	-0.01	0.01
potatoes	0.003	0.01	**0.01**	0.005	**0.01**	0.002	0.0005	0.002	0.004	0.005	**0.02**	0.01	**0.03**	0.01
juices	**-0.34**	0.16	0.011	0.14	-0.04	0.05	0.01	0.07	-0.14	0.13	-0.10	0.15	-0.38	0.20
fruit drinks	-0.40	0.45	0.25	0.38	-0.03	0.13	-0.09	0.18	**0.85**	0.37	-0.67	0.42	-0.17	0.56
income	**0.0003**	0.00002	**0.0003**	0.00002	**0.00005**	0.00001	**0.00005**	0.00001	**0.0001**	0.00001	**0.0003**	0.00002	**-0.0001**	0.00002
constant	**-1.84**	0.22	**-3.08**	0.19	**-0.63**	0.06	0.10	0.08	**-3.23**	0.16	**-4.91**	0.19	**-2.02**	0.26

Note: Bold numbers are significantly different from zero at the 5% level. We also control for seasonal effects, annual effects, and demographics: age of the reference person, occupation, people per household and type of household (rural or urban).

TABLE 6. MODEL 2 DYNAMIC TOBIT MODEL PER FOOD GROUP

		q fresh fruits		q fresh vegetables		q processed fruits		q processed veg		q potatoes		q natural juices		q fruit drinks	
		coefficient	SE	coefficient	SE	coefficient	SE	coefficient	SE	coefficient	SE	coefficient	SE	coefficient	SE
	lagged quantity	**0.29**	0.005	**0.28**	0.005	**0.25**	0.01	**0.16**	0.005	**0.14**	0.01	**0.44**	0.01	**0.32**	0.01
	policy variables														
	campaign A	**0.25**	0.08	**-0.11**	0.07	**0.08**	0.02	**0.16**	0.04	**-0.02**	0.07	**0.19**	0.08	**0.31**	0.10
	campaign B	0.05	0.08	**0.14**	0.07	**-0.03**	0.02	0.10	0.03	**0.19**	0.06	**0.25**	0.07	**0.26**	0.10
	campaign C	**0.37**	0.05	0.017	0.05	**0.11**	0.01	0.04	0.02	**0.02**	0.04	0.07	0.04	**-0.19**	0.06
M	**interaction terms**														
O	campaign A * lag q	**-0.01**	0.005	**-0.05**	0.005	**-0.02**	0.01	**-0.04**	0.005	**-0.03**	0.01	**-0.09**	0.01	**-0.06**	0.01
D	campaign B * lag q	**0.03**	0.004	0.00	0.004	**0.02**	0.01	**-0.01**	0.004	**-0.02**	0.01	**-0.03**	0.01	**-0.01**	0.01
E	campaign C * lag q	**-0.05**	0.004	**-0.04**	0.004	**-0.07**	0.01	**-0.03**	0.004	-0.01	0.01	**-0.09**	0.01	**-0.05**	0.01
L															
	price index														
2	fresh fruits	-0.07	0.04	-0.03	0.04	0.01	0.01	-0.03	0.02	-0.04	0.04	-0.06	0.04	-0.01	0.06
	fresh veg	-0.05	0.03	**-0.06**	0.02	0.00	0.01	**0.03**	0.01	-0.008	0.02	0.03	0.02	0.05	0.03
	proc fruits	-0.005	0.02	0.01	0.02	-0.01	0.01	-0.001	0.01	0.03	0.02	0.01	0.02	-0.02	0.02
	proc veg	-0.004	0.01	**-0.01**	0.01	-0.0006	0.002	-0.002	0.003	**-0.02**	0.01	0.001	0.01	-0.002	0.01
	potatoes	-0.003	0.01	0.01	0.01	**0.01**	0.002	-0.0001	0.002	0.000	0.005	**0.02**	0.01	**0.02**	0.01
	juices	**-0.36**	0.16	-0.08	0.14	-0.05	0.05	0.001	0.07	-0.16	0.14	-0.09	0.15	**-0.50**	0.21
	fruit drinks	-0.43	0.45	0.36	0.39	-0.07	0.13	-0.11	0.19	**0.88**	0.38	-0.50	0.42	-0.34	0.57
	income	**0.0003**	0.00002	**0.0003**	0.00002	**0.00005**	0.000005	**0.0001**	0.00001	**0.0001**	0.00001	**0.0003**	0.00002	**-0.0001**	0.00002
	constant	**-1.11**	0.21	**-2.98**	0.18	**-0.56**	0.06	0.10	0.09	**-3.08**	0.165	**-4.65**	0.19	**-2.16**	0.26

Note: Bold numbers are significantly different from zero at the 5% level. We also control for seasonal effects, annual effects, and demographics: age of the reference person, occupation, people per household and type of household (rural or urban).

TABLE 7. MODEL 3 DYNAMIC TOBIT MODEL PER FOOD GROUP

MODEL 3

	q fresh fruits		q fresh vegetables		q processed fruits		q processed veg		q potatoes		q natural juices		q fruit drinks	
	coefficient	SE	coefficient	SE	coefficient	SE	coefficient	SE	coefficient	SE	coefficient	SE	coefficient	SE
lagged quantity	**0.29**	0.005	**0.28**	0.005	**0.25**	0.01	**0.16**	0.005	**0.14**	0.01	**0.44**	0.01	**0.32**	0.01
policy variables														
campaign A	**0.25**	0.08	**-0.12**	0.07	0.07	0.02	**0.16**	0.04	**-0.02**	0.07	**0.19**	0.08	**0.29**	0.10
campaign B	0.04	0.08	**0.16**	0.07	**-0.02**	0.02	0.11	0.03	0.20	0.06	**0.26**	0.07	**0.31**	0.10
campaign C	**0.37**	0.05	0.004	0.05	**0.10**	0.01	0.03	0.02	**0.01**	0.04	0.07	0.05	**-0.22**	0.06
interaction terms														
campaign A * lag q	**-0.01**	0.005	**-0.05**	0.005	**-0.02**	0.01	**-0.04**	0.00	**-0.03**	0.01	**-0.09**	0.01	**-0.06**	0.01
campaign B * lag q	**0.03**	0.004	-0.003	0.004	**0.02**	0.01	**-0.01**	0.004	**-0.02**	0.01	**-0.03**	0.01	**-0.01**	0.01
campaign C * lag q	**-0.05**	0.004	**-0.04**	0.004	**-0.07**	0.01	**-0.03**	0.004	-0.01	0.01	**-0.09**	0.01	**-0.05**	0.01
price index														
fresh fruits	-0.07	0.04	-0.04	0.04	0.005	0.01	**-0.04**	0.02	-0.05	0.04	-0.06	0.04	-0.01	0.06
fresh veg	-0.05	0.03	**-0.06**	0.02	-0.001	0.01	**0.03**	0.01	-0.009	0.02	0.03	0.02	0.04	0.03
proc fruits	-0.005	0.02	0.02	0.02	-0.01	0.01	-0.001	0.01	0.03	0.02	0.01	0.02	-0.02	0.02
proc veg	-0.004	0.01	**-0.01**	0.01	-0.001	0.002	-0.002	0.003	**-0.02**	0.01	0.0005	0.01	-0.002	0.01
potatoes	-0.003	0.01	**0.01**	0.01	**0.01**	0.002	-0.0003	0.002	-0.001	0.005	**0.02**	0.01	**0.02**	0.01
juices	**-0.36**	0.16	-0.08	0.14	-0.05	0.05	0.003	0.07	-0.15	0.14	-0.09	0.15	**-0.48**	0.21
fruit drinks	-0.43	0.45	0.35	0.39	-0.08	0.13	-0.11	0.19	**0.88**	0.38	-0.50	0.42	-0.37	0.57
income	**0.0003**	0.00002	**0.0003**	0.00002	**0.00005**	0.000005	**0.0001**	0.00001	**0.0001**	0.00001	**0.0003**	0.00002	**-0.0001**	0.00002
newspapers														
cumulated index	-0.01	0.01	**0.03**	0.01	**0.02**	0.004	**0.02**	0.005	0.02	0.01	0.02	0.01	**0.08**	0.02
constant	**-1.12**	0.21	**-2.97**	0.18	**-0.55**	0.06	0.11	0.09	**-3.07**	0.16	**-4.64**	0.19	**-2.13**	0.26

Note: Bold numbers are significantly different from zero at the 5% level. We also control for seasonal effects, annual effects, and demographics: age of the reference person, occupation, people per household and type of household (rural or urban).

Table 8 shows the ATT effect for each phase of the campaign and each food group (on the left-hand side), as well as the total policy effect, in terms of portions, for each food group on the right-hand side (see Section 2.1. for the definition).

Perhaps due to its novelty, Phase A (posters, news and radio ads) led to an increase of +0.13 portions of F&Vs (including natural fruit juices). It also produced some substitution across the F&V groups, with a decrease in purchases of fresh vegetables. Phase B (a TV program consisting of 40 episodes) is the first serious massive effort to promote the 5-a-day concept. It led to an increase of +0.12 portions of F&Vs (including natural fruit juices). In addition, Phase B produced less substitution across the F&V groups, with only a small decrease in the purchases of processed fruits. However, Phase B also increased expenditure on fruit drinks. Phase C (multimedia advertising) led to an increase of +0.14 portions of F&Vs (including natural fruit juices). In addition, Phase C did not produce substitution across F&V groups and decreased purchases of fruit drinks.

TABLE 8. ATT (IN PORTIONS *PER CAPITA* PER DAY)

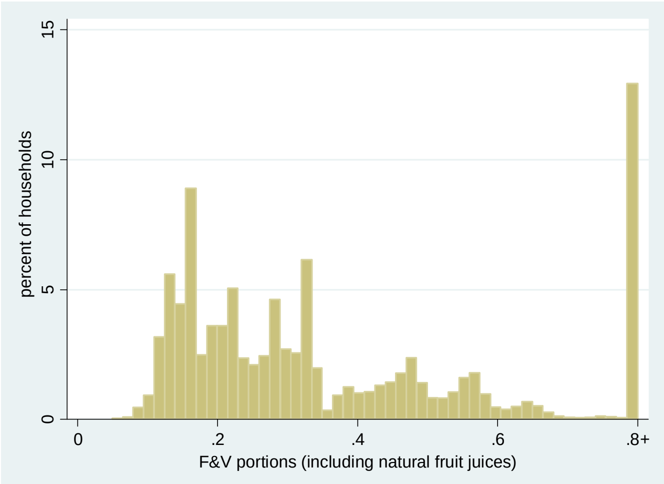
	Effect per Phase (portions per day)			Total Policy Effect (portions per day)			
	A	B	C	mean	SD	min	max
fresh fruits	0.06	0.01	0.09	0.16	0.10	0.02	1.31
fresh vegetables	-0.03	0.04	0.001	0.01	0.01	-0.01	0.21
processed fruits	0.02	-0.005	0.03	0.04	0.03	0.01	0.67
processed vegetables	0.04	0.03	0.01	0.08	0.05	0.01	0.80
potatoes	-0.004	0.03	0.002	0.03	0.02	0.01	0.40
juices	0.03	0.04	0.01	0.08	0.05	0.02	1.04
fruit drinks	0.04	0.04	-0.03	0.05	0.03	0.01	0.73

Note: The first three columns show the impact of each phase in kilograms. The remaining columns correspond to the total effect, which is computed by adding the individual effects of each phase. These results take into account the representative weights.

Taking into account the three phases together (total policy effect), the 5-a-day campaign led to an increase in purchases of fresh fruit, processed fruits and processed vegetables, but also natural juices and fruit drinks. Finally, the minimum and maximum values show a wide range, which means that the 5-a-day campaign causes very different impacts across households.

Figure 2 shows the household distribution of campaign effects in France, which takes into account the three phases of the campaign. Overall, the 5-a-day campaign (including phase A) led to a *per capita* average increase of +0.38 portions per day, with a minimum of +0.05 portions and a maximum of +2.69 portions. The histogram can be separated into three areas. For 50-55% of households, we observe an average policy impact of about +0.2 portions per day. For 20-25% of households, there is a larger impact of +0.5 portions per day. And for the remaining 10-15% of households, the impact is larger than +0.8 portions per day. From a policy point of view, it would be interesting to characterize these three population groups and find ways to enlarge the third population group.

FIGURE 2. EMPIRICAL DISTRIBUTION OF CAMPAIGN EFFECT (IN PORTION *PER CAPITA* PER DAY)



5.2 Other results

The own price effects are all negative in Models 2 and 3, while the income effects are positive and significant, except for fruit drinks. In most cases, F&V groups tend to act as substitutes, which may buffer their overall quantity. After a price change, households might shift from one F&V group to another (fresh fruits, fresh vegetables, processed fruits and processed vegetables). On a positive note, this buffering would mitigate the impact of a price increase in any specific F&V group. On a negative note, this buffering would limit the impact of a price intervention on a specific F&V group that aims to increase the overall quantity of F&V consumed.

For most of the F&V groups, the media news index (geometric mean of the number of articles in the last twelve months) has a positive effect. But its introduction in Model 3 has little effect on the estimated policy effects, which suggest that the media follows the campaign rather than amplifies it.

6 Discussion and conclusion

This article has presented results from an evaluation of the 5-a-day public information campaign in France, which promotes the consumption of at least five portions of F&Vs per day. French households purchase more F&V for food-at-home consumption than before, with an increase of +0.88 portions per household member available each day for consumption. From this overall increase of +0.88 portions, +0.20 portions is due to an increase in the purchases of natural fruit juices, which includes +0.08 portions of the impact of 5-a-day campaign in this group. Our estimates have revealed that the 5-a-day public information campaign has led to an increase of +0.38 portions of F&Vs. In addition, the largest increase is observed for the fresh fruits (+0.16 portions), the processed vegetables (+0.08 portions) and the natural fruit juices (+0.08 portions). As a negative nutritional consequence, there has also been an increase in fruit drinks with added sugar (+0.05 portions). These findings are in line with previous evaluation studies. In a meta-analysis of the literature on small-scale F&V interventions, Pomerleau, *et al.* (2005), who did not distinguish F&Vs from tubers & potatoes, found that F&V interventions can lead to an increase between +0.1 and +1.4 portions in healthy adults. Capacci and Mazzocchi (2011) found an increase between +0.1 and +0.7 portions in UK (+0.3 portions on average).

Our study proposes some additional contributions to the public debate on F&V interventions. For the first time in a demand analysis of the 5-a-day campaign, we included (i) natural fruit juices, (ii) fruit drinks and (iii) tubers & potatoes, each as a separate food group. The inclusion of fruit juices in the analysis had particular relevance since their consumption may have negative health consequences. Unfortunately, the 5-a-day campaign has increased their purchases. We also find, perhaps surprisingly, that the 5-a-day public information campaign has reduced inequalities between households (not social inequalities).

Yet, some additional aspects of the 5-a-day public information campaign may be considered more carefully by future research. First, in the supply side, retailers may adjust their prices in response to the demand variations induced by the 5-a-day campaign. It is not clear if the unit value procedure in this study fully corrects this source of price endogeneity. Second, in addition to the mandatory regulation, some food and beverage manufacturers use the 5-a-day concept to promote their products. The policy concern becomes how the 5-a-day message is being incorporated into food products. Today, some natural fruit juices claim that 250ml (8.45 oz.) represents two portions of the 5-a-day recommendation. As well, in the UK, canned pasta with meat balls and tomato sauce from a well-known national brand claims that half of a can corresponds to one portion of the 5-a-day recommendation. Cullum (2003), after conducting a set of focus groups, expressed her concern that the 5-a-day logo may be misused in products with added fat, sugar and/or salt. Hence, the unintended impacts of the campaign have to be fully addressed. Third, the frequency of purchase is another interesting evaluation outcome. In the UK, Ashfield-Watt *et al.* (2004) found that high and low consumers eat similar portion sizes of F&Vs. Nevertheless, high consumers eat more often than low consumers. We are not aware if a similar study has been done in France. From a public policy point of view, purchase frequency patterns can be an interesting aspect to include in future analysis that can help to inform social marketing messages as well as F&V voucher campaigns. Fourth, the "5-a-day" French campaign partially moved from a public information campaign paid for by the government to mandatory information messages in the media paid for by the food manufacturers. Since February 2007, food and beverage manufacturers have been required to include a healthy message in their media advertising (television, radio, cinema, press and internet). Some examples of these healthy messages are “eat at least five portions of fruit and vegetables”, “limit fat, sugar and salt consumption” and “get regular physical activity” (Hercberg, *et al.*, 2008). Alternatively, companies can avoid including one of these healthy messages if they pay 1.5% of their advertising expenditure to the National Institute of Health Education and Prevention (INPES), which is the public agency in charge of promoting a healthy lifestyle. It would be interesting to measure the cost-effectiveness impact of this shift from a public funded to a private funded campaign.

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