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Folic acid advisories, a public health challenge?

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Abstract

Neural tube defects are neurological conditions affecting 1 in 1000 foetuses in France each year. If a foetus is affected there is a 90% chance of the pregnancy being terminated. Increasing folic acid intake over 400μg per day two months before and two months after conception reduces prevalence rates by 80%. Two types of government interventions exist to increase intake and reduce prevalence rates: (1) fortification of staple food, which increases population intake indiscriminately; (2) social marketing seeking to increase intake of conceiving women through information provision. France opted for the latter and has implemented it since mid-2005. This paper sets up a quasi-experimental setting to measure the impact of the french social marketing campaign on consumption using a reduced form approach. I combine a detailed scanner data on grocery purchases with a dataset on macro- and micro- nutrients. Identification exploits the variation in the usefulness of folic acid information between households: households that are conceiving or want to conceive a child use it, while those that are not conceiving do not. Results suggest evidence of a positive impact of the information policy on folic acid household availability and preferences. A value per statistical life for children is found to be at least of € 17 milliions.

JEL Codes: C21, D12, I12, I18, J17.
Keywords: Folic acid, health information, structural demand estimation, public health.

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1 Introduction

A topic of public health concern in France in recent years has been the governments' level of intervention on major preventable diseases, neural tube defects. Neural tube defects (NTD) are conditions affecting 1 in 1000 foetuses each year.[1] An average of 90% percent of NTD cases are terminated.[2] Epidemiological evidence suggests that in order to reduce by 80% the number of NTD cases, pregnant women need to intake a daily dose of 400μg of folic acid two months before and after conception.[3] [4] The market failure lies on the lack of information about the perils of low folic acid diets. Globally, governments have focused on two instruments to reduce NTD prevalence: (1) fortification, whereby folic acid intake is artificially increased by spraying folic acid onto staple foods; (2) information provision and pill supplementation to individuals at-risk, mainly, women that are pregnant or that want to have a child. In theory, either policy could reduce the prevalence. In practice, little is known about their relative success.

This paper exploits a dramatic change in policy to evaluate the impact information has on consumers' grocery purchasing behaviour in France. Also, it constructs a risk-benefit analysis evaluating the welfare effects of an ex-ante fortification policy. In 2004 the french government laid down the legal foundations for a massive public health policy campaign: Plan National de Nutrition Santé, PNNS.[5] Reducing neural tube defects prevalence by improving the folate status of individuals at-risk was amongst its targets. A nation wide folic acid social marketing and supplementation campaign has been implemented since mid-2005.[6] The advice specifically urged women in childbearing age, wanting to get pregnant or pregnant women, to take necessary precautions in order to decrease the risk of NTDs to their offspring - through either a healthier diet or/and the intake of folic acid supplements. Figure 1 displays the NTD trend in Paris from 1981 to 2012. The policy seemed to have helped decrease the NTD prevalence.

I exploit the search and need for information on pregnancies experienced by pregnant households, coupled with the exogenous information shock from 2005 onwards to identify changes in consumption patterns for folic acid.[7] I use a large french representative household grocery purchase dataset from 2003 to 2009. The data contains information on a wide range of products and household demographics. I couple grocery purchase information with information on macro- and micro- nutrients using two additional datasets. To

[1] NTD is a condition that affects foetuses' spine formation and manifests itself in either of two forms: as bifida-spine - a condition in which the vertebrae does not form a complete ring to protect the spine or in the more severe form called anencephaly wherein the brain is not build up in the embryonic state.

[2] In France there is no upper gestational age limit on the termination of a pregnancy provided an expert approves that "there is a high probability that the foetus is affected by a particularly severe condition with no effective therapy available at the time of prenatal diagnosis" (Law July 1994).

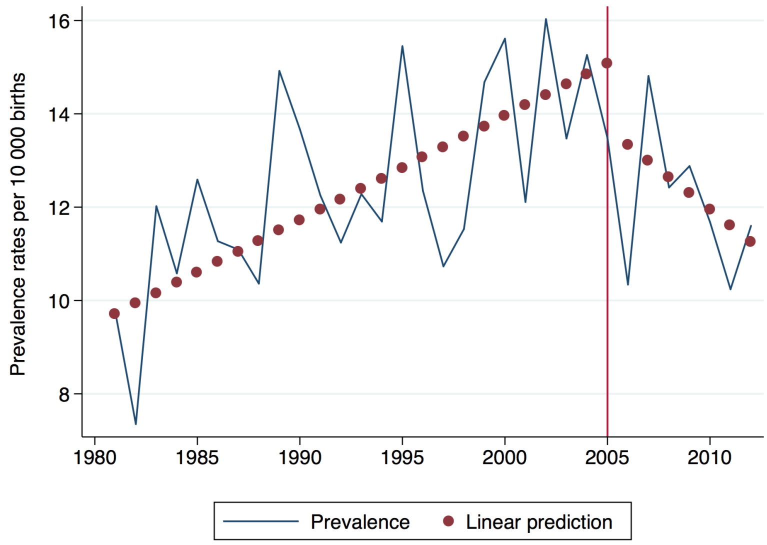
[3] The development of the foetuses' spinal cord is done on average at the 24th day after conception, so folic acid effectiveness is limited to this period. The reason is explained in detail in section G.

[4] Actually, 1 μg of dietary folate is equivalent (DFE) to 0.6 μg of folic acid from fortified food or as a supplement taken with meals. It is also equivalent to 1 μg of food folate or 0.5 μg of synthetic folic acid taken on an empty stomach. I will use folic acid and folate indiscriminately as in my analysis they I make them equivalent.

[5] Adopted during summer 2004, it set important objectives in terms of public health such as: decrease alcohol consumption by 20%, cut by 20% overweight and obesity prevalence, reduce salt consumption below 8g per day, and many more.

[6] The Direction Générale de la Santé (DGS) issued a consumption advice through the Institut National de Promotion Education Santé (INPES), which warned consumers about the possible health hazards resulting from an insufficient daily intake of folic acid.

[7] Women need, search and acquire information when they want to get or are already pregnant. Information acquisition happens before or quite early during the pregnancy; 92% of antenatal visits in France happen before the first trimester (Peristat, 2010).



Notes: Prevalence estimates are taken from EUROCAT. The fitted values here plotted are taken from a regression including data from Paris and Strasbourg registries. Regression results can be found in the appendix.

Figure 1: Neural tube defects prevalence in Paris, France.

analyse the purchase behaviour, I use two complementary methods: (1) a reduced form approach, which captures the changes in average daily folic acid levels the per person; (2) a structural approach, which captures changes in preferences for folic acid.

Estimates suggest that the information policy had a small, yet identifiable effect. Despite treated households' pre-policy lower consumption level of folic acid, the information campaign increased treated households' consumption by an additional 4%. Also, households that reacted more to the policy were found to be younger, lower educated and having their first child. Additionally, the effect is found to be uneven as a treated household in the 90th percentile (of the folic acid distribution intake) reacts 1.5 times more than a median household.

The effect is not limited to consumption. Preferences for individuals at-risk changed as a result of the policy. Finally, using the results from the structural model I am able to compute a lower bound of the value per statistical life for children of € 17 millions.

The remainder of the paper is organized as follows: section 1 introduces; section 2 provides a background on the french NTD policy; section 3 presents the dataset used in the paper; section 4 presents the theoretical and empirical strategy; section 5 presents results; section 6 concludes and discusses.

2 The information policy

2.1 Method of transmission of the information

The French government opted to provide information about the potential harms of poor folic acid diets and subsidize supplementation to women at-risk, rather than to fortify staple products as is done in the US or Canada.[8] [9] France has opted for a precautionary strategy regarding fortification due to the evidence of possible secondary effects.[10]

By summer 2004 the french government passed a bill in favour of promoting public health. Two of such specific objectives were to increase iron and folic acid intake of pregnant women to decrease the likelihood of anaemia and neural tube defects, respectively. The task of informing individuals at risk about how and why to increase their folic acid and iron intakes was given to the INPES. By 2008, there were two broad public campaigns undertaken by the INPES. The first wave was done in 2005, and the second in 2007. Both campaigns had the same transmission mechanism. The information was directed to individuals at-risk, as well as care givers (doctors both specialist and generalist, dietitians, pharmacists, gynaecologist, nurses). Transmission was ensured in the form of booklets and posters providing guidance on what type of food to eat and when to eat it, as well as through the web page "www.mangerbourger.fr" or in the case of caregivers, by e-mail.

Information provided in the booklet destined to women summarized key information about hygiene, physical activity, smoking, food choices and preservation, as well as nutritional needs and information concerning pregnancy. The information was based on the best available scientific knowledge. While the information provided in the booklet for caregivers summed up scientific findings related to women's nutrition.

2.2 The reception of the advisory message

As the nutrition campaign for pregnant households makes part of a broader campaign, it is important to know how the entire campaign has evolved. The annual budget for communication purposes for advisory campaigns has been around 10 millions € per year (INPES, 2010). Being charged of providing the information to stake holders, INPES is also responsible of evaluating the broadcasting success.

Every 18 months, since 2005, INPES has done a series of surveys asking questions about the information campaign. Results from these surveys suggest that the PNNS messages awareness concerning fruits and vegetables increased from 36% in 2005, 68% in 2008 up to 75% in 2009. The PNNS logo was recognized by 28% in 2008 against 19% in 2005. The awareness of the webpage www.mangerbouger.fr passed from 13% in 2006, to 48% in 2008. More importantly, the webpage is spontaneously taken as a nutritional guide by 11% of individuals in 2009, against 1% at the end of 2005, (Castetbon et al., 2009). Additionally, 74% of respondents, considered that the PNNS messages concerning nutrition are credible. By the end of 2007, around 3 million documents concerning pregnant women nutrition, between posters and booklets, were distributed around France (Rapport activité INPES, 2007; communication INPES, 2005). In a survey evaluating the notoriety of the printed material, INPES found that 5% of individuals reported having read the booklets concerning nutrition during the periconceptional period.

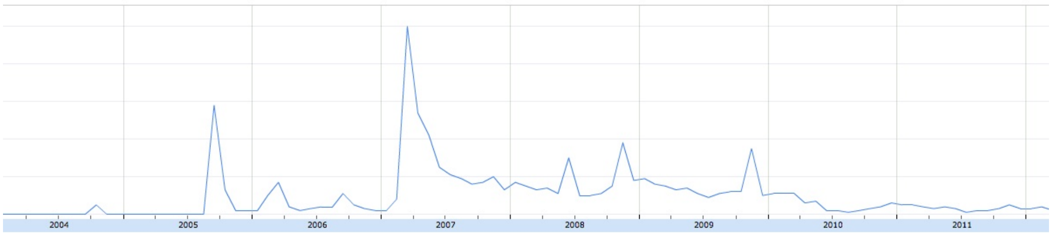
An indicator of whether French consumers became aware of the information provided by the campaign is to look at web searches in Google Trends, a Google based program that allows tracking on how often keywords are looked for in the web. Figure (2) illustrates the searches in Google for "manger bouger", the slogan of the campaign. It shows that there is a peak in 2005 and 2007 consistent with the introduction and the rerun of the advisory

[8] Actually both Canada and USA started their fortification process in the late 1990's. The overall impact on NTDs could be seen as a potential success. There has been a 70% reduction of cases. Still, I do not know of a study proving causality of this statement.

[9] Documentation of what has been done previous to 2004 in France can be found in the appendix

[10] Appendix G gives an exhaustive epidemiological summary of the pro's and con's of folic acid.

campaigns by the DGS. However, a deeper understanding of the consumption behaviour of individuals at-risk is needed.



Notes: Each peak corresponds to a advertising campaign done by the DGS nation wide.

Figure 2: Searches in Google for "manger bouger"

The public health effect of this policy on the outcome variable, prevalence rates, seems to be pointing in the right direction. Figure 1 shows the total prevalence rate in Paris from 1981 to 2012. It suggests that the information campaign could have had an impact on reducing the NTD prevalence, as a break in the trend occurred after 2005. l0I am interested in investigating the factors that lead to the 2005 break in the trend. Was the awareness raised? Did it translate into changes in shopping behaviour? More importantly, did it increase folic acid intake? And in this case, was it the result of a higher intake of food related folic acid or folic acid through supplementation?

3 Data sources

I wish to examine the impact of the 2005 advisory campaign over in-household food consumption. To do so, I need two pieces of information. First, who was more likely to use the policy? Second, how did the content of their diets change after the 2005 information advisory was implemented?

As seen previously, the advisory was targeted to women wanting to become pregnant, pregnant, or women that previously had a child with a NTD. Information on the perils of low folic acid diets, on what and when to consume folic acid intensive food is likely to change the behaviour of individuals requiring this type of information. Individuals' behaviour that do not want to become pregnant, by contrast, should not the affected by the 2005 information campaign. The latter provides my control group, and the former group provides my treatment.

To implement this strategy, I need data on individuals food consumption and their micro nutrient intakes, as well as data on their conception periods (conditional on being pregnant), both before and after the information campaign. My primary data source combines highly detailed datasets: (1) rotating panel dataset Kantar Worldpanel; (2) Individual product macro and micro nutrients (CIQUAL); (3) Pill supplementation purchases and intakes from National Perinatal Surveys (NPS), Bulletin Epidemiologique Heddomadaire (BEH) and MEDICAM. The following subsections describe each of the datasets used.

3.1 In-household food consumption: Kantar Worldpanel

Data on household purchases is obtained from the Kantar Worldpanel data base. It consists on a homescan data on grocery purchases made by a representative sample of households in France from 2002 to 2009. These data are collected by household members themselves with the help of scanning devices. [11]

The data set contains information on 352 different variety of grocery products from around 90 grocery stores including hyper- and supermarkets, convenience stores, hard-discounters and specialized stores. The data is reported at the purchase level, so I observe product characteristics such as total quantity, total expenditure, the store where it was purchased from, the brand, amongst others.

Table 1 gives summary statistics of demographic characteristics from households where a women is the person in charge of reporting purchases. I limit my attention to women aged between 18 and 45 years old. The table is divided into two groups: (1) Not treated households, which are households that did not have a child; (2) treated household, which are households that did have a child or are conceiving one.[12]

On one hand not treated household are in average 36 years old both before and after the policy was implemented, have an average body mass index (BMI) of 24 in both years, their income increases from 2200 to 2500, the share of households having only one child remained stable at 23% and the share of women having a college degree increases from 0.23 to 0.27. On the other hand, treated households are 30 year old, have a constant BMI, their income increases from 2400 to 2800, the share having a first child increased slightly from 33% to 34% and the share of women having a college degree decreases from 0.37 to 0.33. As noted in the last column of table 1, there is no significant change in the differences between both groups.

To have an idea on the purchase behaviour of individuals, I divide the products in my dataset into 9 macro categories following Dubois et al. (2014). Table 2 is a summary on how the products are categorized into the 9 sections. Table 3 reports on the average expenditure per person, per category and per day. In a day a person spends on average 30 cents on fruits and vegetables, 60 cents on dairy, 40 cents on grains and 50 cents on prepared food. Treated households consume more at home both before and after the policy of every category expect for Meats, Fats and Sweeteners.

3.2 Aggregate micro-nutrients dataset: CIQUAL

As the macro and micro nutrients are not reported in Kantar Worldpanel dataset, I take data from CIQUAL (2012) to complement it. It contains over 50 characteristics per product (sugars, fats, fibres, vitamins, minerals, . . .), for over 1500 products. The data is collected by the Agence National de Sécurité Sanitaire (ANSES) from different sources.[13]

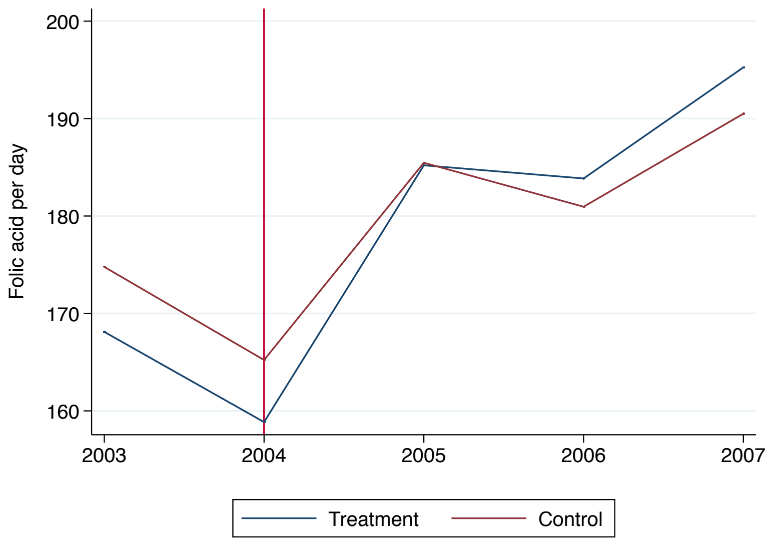
Each of the 352 categories are matched with average category characteristic values found in CIQUAL.[14] By combining purchase quantities from Kantar with average cate-

[11] Most households integrating the panel were randomly sampled since 1998 (the Kantar Worldpanel is a continuous panel database starting from 1998). Every year, new randomly selected households are added to the panel either as a replacement of other household rarely reporting data or because sample size is increased.

[12] A more detailed explanation on how the groups are constructed is found in Appendix B

[13] Only 80 products are analysed by ANSES laboratories, but the rest are taken from collaborations with research organisms, producers, retailers and others. Each product is sampled at least once, and characteristics are taken for each product.

[14] To fix ideas, bananas are matched with the average characteristic values for bananas found in CIQUAL (2012). In the case of breakfast cereals, it implies that the brand Special K will have the same characteristics as Corn Flakes.



Notes: Only households where women are the persons in charge of reporting purchases, aged between 18 and 45 years old are included. Daily folic acid availability is computed by taking the average quarter availability and dividing it by the appropriate number of days. Household equivalence scale based on daily caloric requirement of all household members divided by 2,500.

Figure 3: Daily per person folic acid availability

gory characteristics from CIQUAL, I am able to compute an estimate of the dietary folate availability from each category, conditional on purchase. Table 4 reports the average contribution per category on the overall daily folic acid availability. The highest contributor to folic acid availability are grain products followed by dairy products. Vegetables, and fruits, while having the highest concentrations of folic acid per grams, are the third and four contributors, respectively. While figure 3 displays the daily folic acid availability among treated and not treated households from 2003 to 2007. Previous to the policy daily folic acid availability trends are similar, but after the policy daily folic acid availability for treated increases more than for not treated households.

There are several limits to the dataset constructed so far. First, only purchases are observed and not intake. Household equivalent scales are used to mitigate this limitation. Second, consumption out-side of the household is not observed, so any change in behaviour in out-household consumption that affects in-household food consumption will not be accounted for. The following section presents assumptions to be made to deal with this issue. Nevertheless, Kantar Worldpanel captures 70% (170μg of 240μg, INCA 2 2006) of total daily folic acid availability.

3.3 Pills data

Data on pill supplementation comes from three sources: (1) Bulletin épideḿiologique hebdomadaire (BEH), which surveyed pregnant women on 1995 and 1999; (2) National Perinatal Surveys (NPS), which surveyed pregnant women on 2010; Medicam, that reports on the price and number of pills reimbursed by the french social security from 2002 until

2012.[15]

BEH randomly sampled 735 (733) women who recently had given birth among 16 registries in Paris during June 1999 (1995). The survey targeted the consumption of folic acid pills before and during pregnancy. Images of the most used multivitamins were provided to aid memory recognition.[16] Only 177 (24%) took folic acid, with 7 (1%) taking it before the first month of pregnancy. Conditional on consuming supplementation pills, nearly no auto medication was seens: prescription rate was of 92%.

NPS National Perinatal Surveys are surveys designed to monitor perinatal health (Tort et al. 2013). Women were interviewed in the maternity unit 2 or 3 days after delivery about their socio-demographic characteristics, health behaviours, birth planning and fertility treatments.[17] The final sample consists on 12,646 women.[18] In total, 15% of women took folic acid supplementation before the first month of pregnancy and 44% (5565) took folic acid during pregnancy.

Finally, data on the number and expenditure on folic acid pills is obtained from MEDICAM dataset. It reports on the prices and numbers of boxes reimbursed by the social security in France.[19] The number of reimbursed 400μg pills have increased from 0 to nearly 40 pills per baby born in France. The average costs per pill has remained stable since 2002 at 0.124 cents and the reimbursement rate is 65%.[20]

The limitation of these datasets is that neither yields detailed information on the actual number of number of pills taken by pregnant women.

4 Theory, identification and estimation

I model demand for food at home at an aggregated level following Dubois et. al (2014) (here onwards labelled as DGN). The model assumes demand is based on products and their nutrients, and preferences over other food attributes (e.g., taste, texture, appearance) that may or may not be observed by econometricians. The model builds on Gorman (1980) and Lancaster (1966), where utility depends on the characteristics of the products.[21]

4.1 A demand model

A household choice set consists on N products, where product n is characterized by C nutrients $\{a_{n1}, ..., a_{nC}\}$, were C is smaller than N. As in DGN, the utility of household i with demographics η_i is given by $U(x_i, z_i, y_i; \eta_i)$ where x_i is the numéraire, z_i is a $C \times 1$ vector of aggregated nutrients of food and y_i is a vector of the quantities purchased of

[15] Kantar Worldpanel data does not contain information on household consumption of supplements. It is necessary to account for folic acid pill supplementation as 1 pill it can satisfy the required levels for a pregnant woman in a day. The ideal approach is to analyse total, food and supplements, folic acid availability data and to see whether or not at-risk households changed their intake.

[16] France introduced folic acid with 400μg pills in 2003. Before it was only available in multivitamin pills.

[17] In 2010 NPS asked for the first time about folic acid supplementation: "Did you use folic acid or vitamin B9 for prevention of NTDs for this pregnancy?" Conditional on consuming, the follow up question was "When did you start: more than 3 months before conception, between 1 and 3 months before conception, first month of pregnancy or after the first month?"

[18] From an initial sample of 14,266 women; 664 (4.6%) of them were not interviewed and 956 (6.7%) women did not know if they had used folic acid or when they began it.

[19] Since 2003 there are two manufacturers producing folic acid pills on a 400μg format: (1) ACIDE FOLIQUE CCD, introduced late 2002 has 30 pills per box; (2) SPECIAFOLDINE, introduced early 2003 has 28 pills per box.

[20] To my knowledge, multi-vitamins have a zero reimbursement rate in France.

[21] A detailed description of the model is given in Dubois et al. (2014).

all food products by household i. Define the $N \times C$ matrix $A = \{a_{nc}\}, n = 1, ..., N, c = 1, ..., C$. a matrix of product characteristics. Household maximize utility by choosing the quantity of the numéraire, x_i, and of food items, y_i, subject to a budget constraint:

$$\begin{aligned} &\max_{x_i, \mathbf{y_i}} \quad \mathcal{U}(x_i, \mathbf{z_i}, \mathbf{y_i}; \eta_i) \\ &s.t. \sum_n p_n y_{in} + p_0 x_i \leq I_i \\ &\mathbf{z_i} = \mathbf{A}^{'} \mathbf{y}; \\ &x_i,\, y_{in} \geq 0\,, \end{aligned}$$

where p_n denotes the price for product y_{in}, I_i corresponds to households i income and p_0 is the price of the numéraire good x_i.

Assuming that quantities y_{in} are continuous, that $y_{in} > 0$ and dropping the subscript i, the first order conditions are given by:

$$\frac{\partial \mathcal{U}/\partial y_n}{\partial \mathcal{U}/\partial x} = \frac{p_n}{p_0} - \sum_{c=1}^{C} a_{nc} \frac{\partial \mathcal{U}/\partial z_c}{\partial \mathcal{U}/\partial x}.$$

Demand depends on hedonic prices $\frac{p_n}{p_0} - \sum_{c=1}^{C} a_{nc} \frac{\partial \mathcal{U}/\partial z_c}{\partial \mathcal{U}/\partial x}$. If the marginal utility for a nutrient is negative, two products with the same prices will have different demands depending on their content of such nutrient: a higher nutrient content leads to higher hedonic prices, thus a lower demand.

Next products are grouped into J macro categories, each with K^j products inside. I add an additional category consisting on supplementation pills, with 1 product inside, so that I have J+1 categories. Each product n is now labelled kj. The utility function has the following specification:

$$\begin{aligned} \mathcal{U}_i(x_i, y_i) &= \prod_{j=1}^{J+1} \left(\prod_{k=1}^{K^j} f_i(y_{ijk}) \right)^{\alpha_{ij}} \prod_{c=1}^{C} z_{ic}^{\beta_{ic}} \exp(\nu_i x_i) \\ z_{ic} &= \sum_{j=1}^{J+1} \sum_{k=1}^{K^j} a_{cj} y_{ijk} \\ f_i(y_{ijk}) &= \lambda_{ijk} y_{ijk}^{\theta_{ij}}, \end{aligned}$$

where ν_i is the income elasticity, λ_{ijk}, θ_{ij}, α_{ij} and β_{ic} are individual preference parameters. Maximizing utility subject to the budget constraint, and summing over the k for a given j, yields:

$$\begin{aligned} \omega_{ij} &= \sum_{c}^{C} p_0 \frac{\beta_{ic}}{\nu_i} s_{ijc} + p_0 \frac{\alpha_{ij}\theta_{ij}}{\nu_i} \qquad (1) \\ s_{ijc} &= \frac{\sum_{k=1}^{K^j} a_{cj} y_{ijk}}{\sum_{j=1}^{J} \sum_{k=1}^{K^j} a_{cj} y_{ijk}}, \end{aligned}$$

where $\omega_{ij} = \sum_{k=1}^{K^j} p_{jk} y_{ijk}$ is the expenditure on household i in category j at period t. Here s_{ijc} corresponds to the nutrient share that category j has overall the nutrient c availability for individual i.

4.2 Identification of the impact of the information campaign

To identify changes in amounts and preferences for folic acid, my identification strategy relies on two important sources of variation. The first one considers the underlying need for such information. Households not wanting to become pregnant will not use such information, thus I would expect that their behaviour would be unaltered when receiving the additional information. Whereas, I would expect that a household that wants to become pregnant is going to alter its behaviour in light of this information. Given that I observe the birth dates of babies, I can make the distinction between households that could use that information from households that do not. Pregnant or conceiving households are in the treatment group, g_c, whereas not pregnant nor conceiving household are in the control group, g_t.

There are three important remarks to be made: (A) a household might be trying to have a child and not succeeding; (B) I do not observe the intention of having a child, so a household might have a child serendipitously and not have changed their behaviour before the pregnancy; (C) households could already know the importance of having proper levels of folic intake. If a households falls within (A) and follows the recommendations I will not be able to account for it, as (A)-type households will not be in group g_t but rather in group g_c. If a households falls within (B) or (C), they might not react to the policy.

The second source of variation is the timing and continuous effort of the policy. I expect to see households for which information about folic acid is useful and relevant, change their behaviour after they receive it. The years before 2005 are pre-treatment and the years after 2005 are post-treatment. One drawback is that I do not observe if households do receive the information, but given the magnitude of the policy, I would expect that the average household receives it, at least, upon knowing they are pregnant.

To understand the identification strategy I will closely follow Chaisemartin et. al (2014). Let t $\in \{t_0, t_1\}$ denote time and g $\in \{g_c, g_t\}$ denote control (g_c) and treatment (g_t) groups. Treatment status is binary and is denoted by an indicator D. Let $Y(1)$ and $Y(0)$ be the potential outcomes (amount or preferences) of an individual with and without the treatment. Only the actual outcome $Y = Y(1)D + Y(0)(1 - D)$ is observed. Let,

$$\forall (i, j) \in \{g_c, g_t\} \times \{t_0, t_1\}, Z_{i,j} = Z | t = i, g = j.$$

Denote the average treatment effect on the treated as, $ATT_{i,j} = \mathcal{E}\left(Y_{i,j}(1) - Y_{i,j}(0) | D = 1\right)$. Moreover, denote $\mathcal{P}_{t_0,g_c}$, $\mathcal{P}_{t_0,g_t}$, $\mathcal{P}_{t_1,g_c}$, $\mathcal{P}_{t_1,g_t}$ the share of always takers (always compliant with the treatment) conditional on belonging to the control and treatment group before the treatment, and the share of always takers belonging to the control after the treatment, respectively.

The DID of a random variable Z is denoted by:

$$DID_Z = \mathbb{E}\left(Z_{t_1,g_t}\right) - \mathbb{E}\left(Z_{t_0,g_t}\right) - [\mathbb{E}\left(Z_{t_1,g_c}\right) - \mathbb{E}\left(Z_{t_0,g_c}\right)].$$

As Chaisemartin et. al (2014) and Abadie (2005), I make a common trend assumption which is at the basis of the DID approach:

$$\mathbb{E}\left(Y_{t_0,g_t}(0) - Y_{t_1,g_t}(0)\right) = \mathbb{E}\left(Y_{t_0,g_c}(0) - Y_{t_1,g_c}(0)\right). \tag{2}$$

Chaisemartin (2012) shows that DID_Y, where DID_Y is the difference in difference on the outcome Y, can be written as a weighted DID of four average treatment effects.

$$DID_Y = ATT_{t_1,g_t}\mathcal{P}_{t_1,g_t} - ATT_{t_0,g_t}\mathcal{P}_{t_0,g_t} - [ATT_{t_1,g_c}\mathcal{P}_{t_1,g_c} - ATT_{t_0,g_c}\mathcal{P}_{t_0,g_c}]. \quad (3)$$

Withtout further assumptions, no causal interpretation can be given to DID_Y in equation (3). Assuming a constant treatment effect $ATT_{t_1,g_t} = ATT_{t_1,g_c} = ATT_{t_0,g_t} = ATT_{t_0,g_c} = ATT$, equation (3) can be re-expressed in the following way: [22]

$$ATT = \frac{DID_Y}{DID_D}. \quad (4)$$

The average treatment on the treated corresponds to the Wald-DID. As I cannot directly observe the difference in the trends for treatment status, DID_D, the effect captured by DID_Y corresponds to a lower bound of the average treatment on the treated if and only if DID_D is strictly positive and strictly smaller that unity. This will be satisfied if the following conditions are ensured: (1) there are not too much treated individuals in the control group, $\mathcal{P}_{t_0,g_t} \geq \mathcal{P}_{t_0,g_c}$; (2) the relative growth rate of the treated individuals in treatment group is not too small as compared to treated individuals in the control group. Provided that the treatment group captures relatively well the treatment individuals, there is no reason to believe that DID_D is negative, nor bigger than unity.

4.3 Estimation approach

In this section, I introduce two ways of analysing the information policy: (1) I explore overall folic acid availability of from products bought by both, treated and not treated households before and after the policy; (2) I investigate if treated household preferences are influenced by this policy.

4.3.1 Reduced estimation

To characterize the effect of the information campaign on folic acid availability on treated households, I use the quarter average nutrient availability. The basic regression specification is the following:

$$z_{it} = \kappa + \lambda \mathbb{1}_{i,treat} \times \mathbb{1}_{year>2004} + X_{it}\beta + \delta_t, + \tilde{\epsilon}_{it} \quad (5)$$

where z_{it} is the total availability of folic acid purchased by household i in quarter t, κ is a constant, $\mathbb{1}_{i,treat}$ is an indicator function taking the value 1 if the household is a treated household and 0 otherwise, $\mathbb{1}_{year>2004}$ is an indicator function taking the value 1 if the period of purchase was made after 2004, and $\tilde{\epsilon}_{it}$ rationalizes all other idiosyncratic variations. Note that z_{it} corresponds exactly to the nutrient content from the theoretical model for a household i in period t.

The coefficient of interest is λ. This coefficient captures the relationship between the policy and treated households' reaction to it. If the policy did raise awareness and passed into action the λ coefficient should be positive.

[22] Assuming constant treatment effect implies that an individual within the treatment group (ie. a conceiving women) is as motivated to react upon treatment than a treated in the control group (ie. women in control that wants to have a child but is not pregnant yet or a woman whose conceiving state is unobserved).

4.3.2 Structural estimation

The estimating equation of the structural model comes from (1). As prices and quantities vary over time, the empirical specification requires a time subscript t. Assuming that the indexed nutrient $c = 1$ is unobserved, and introducing a department subscript, r, yields: $p_0 \frac{\beta_c}{\nu_i} s_{ijc} + p_0 \frac{\alpha_{ij}\theta_{ij}}{\nu_i} = \delta_{ij} + \xi_{jrt} + \epsilon_{ijt}$. Normalizing the price of the outside good and the marginal utility of income to one, $p_0 = \nu_i = 1$, yields the estimating equation:

$$\omega_{ijt} = \sum_{c=2}^{C} \beta_{ic} s_{ijct} + \delta_{ij} + \xi_{jrt} + \epsilon_{ijt}. \tag{6}$$

The household-category fixed effects, δ_{ij}, capture differences in category specific preferences between households. It allows for situations such as a household preferring more vegetables than another, regardless of time or place. Category-department-quarter fixed effects, ξ_{jrt}, capture preference variation of time and place.

The remaining idiosyncratic variation is rationalized by ϵ_{ijt}. It includes, but it is not limited to, preferences shocks and changes in unobserved nutrients. Preferences shocks are likely to affect the quantities of the products being bought.[23] Shares, s_{ijct}, and the idiosyncratic shocks, ϵ_{ijt}, are likely to be endogenous.

To correct for such endogeneity DGN propose to use the variation of available products and their attributes. Conditional on controlling for household preference heterogeneity, variation of available products are due to exogenous reasons: entry and exit of products, or stores. Consumer preferences are controlled for using a large set of households, category and time specific fixed effects.

The ideal situation is to observe the set of available products (and their nutrients) that a consumer can purchase from within the stores she visits. Using this set it is be possible to use as instrumental variable the average nutrient content of the choice set. The caveat is that only purchased products are observed. It is possible, however, to approximate product availability by constructing a set of products bought within a reference "group". This allows to have variation in the IV while avoiding correlations through quantities, or frequency of purchase. The reference group is defined in the following way: (1) within a quarter-department I identify the retailer that was most frequented for the purchase a category j of products by each consumer along with the day of the week it was most visited; (2) consumers with the same most frequented retailer on the same day of the week are considered to belong to the same reference group. The choice set per category for each retailer on a day of the week is approximated by taking all the products purchased by the consumers in the reference group. Next, I to compute for each category j the average nutrient content of the approximated choice sets. These can be used as IVs. The identifying assumption is that the variation in this average is uncorrelated with the error term.

Let $A_{h(ijt)}$ denote the choice set of products in category j for i's "reference" household group in period t. The average nutrient content for nutrient c in category j within the reference household group $h(ijt)$ is denoted by:

$$\psi_{h(ijt)c} \quad = \quad \frac{1}{\# A_{h(ijt)}} \sum_{k \in A_{h(ijt)}} a_{kjc}. \tag{7}$$

[23] As quantities y_{ijkt} are a result of an optimization process they depend on changes of unobserved characteristics.

where $\#A_{h(ijt)}$ corresponds to the number of products in set $A_{h(ijt)}$. I will label these as IV-DGN. As each household may have a different reference type for each category of products, reference's ijt nutritional share for nutrient c is given by:

$$s\psi_{h(ijt)c} = \frac{\psi_{h(ijt)c}}{\sum_j^J \psi_{h(ijt)c}}. \tag{8}$$

Identification requires assuming the unobserved shocks ϵ_{ijt} to be: (1) uncorrelated with included nutrients a_{kjc}; (2) uncorrelated with the products that are bought by the reference group $A_{h(ij't)}$ for all j'. The identifying assumption is that for $c = \{2, \ldots, C\}$:

$$E(\epsilon_{ijt}|s\psi_{h(ijt)c}, \delta_{ij}, \xi_{jrt}) = 0. \tag{9}$$

5 Results

The following section presents reduced form results of the impact of the information campaign on folic acid availability. The section also presents results from the structural model.

5.1 Reduced form results

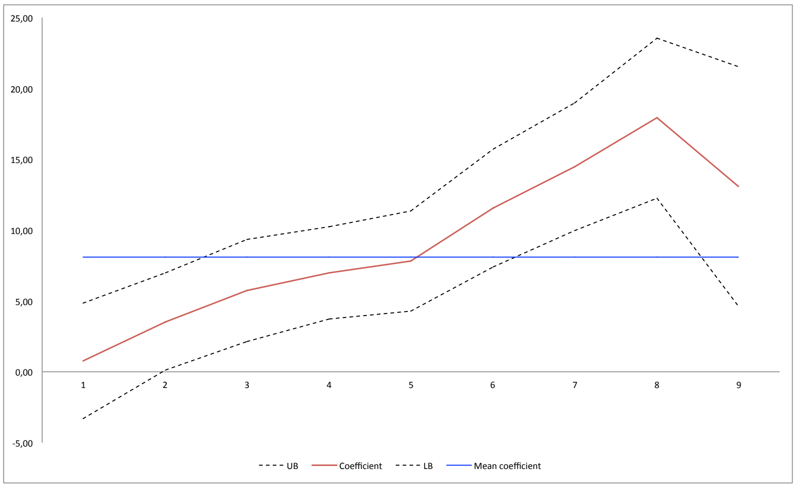
In table 5, I display 3 DID estimates (3 different models) of the impact of the information policy on food folic acid availability. Observations are on the household-quarter level. The dependent variable is the same across all regressions and corresponds to the household folic acid content per quarter. The panel analyses the sample of women between 18 and 45 years.

According to the two regressions, without and with controls for demographics, households that are pregnant or conceiving a child consume 6μg-9μg per person per day less than households that are not treated. The impact of the policy increased treated daily folic acid availability by 7μg per day. Model (3) investigates the heterogeneity in the treatment effect. If the household is having their first child, the impact of the information policy is more pronounced. The opposite effect occurs in older, more educated households, while richer households tend to have a higher impact.

Figure 4 reveals that the per-capita increase in daily folic acid availability occurs almost everywhere along the distribution, except for the leftmost part. The effect is, however, uneven as treated households with higher daily folic acid availability react more. A treated household in the 90th percentile reacts 1.5 times more than a median household.

Identification of the average treatment effect on the treated through DID relies on a common trend assumption. To test this assumption, I display in figure (3) the mean folic acid availability per year among the treated and not treated households. Previous to the advisory campaign both trend are similar, but after the policy, the levels for treated households increase more than for not treated households.[24]

[24] I check the effect of the policy on other micro nutrient availabilities: iron, iodine and calcium. Treated households consistently have lower levels of nutrients than non treated households. According to the iron regression, daily iron availability increases for treated women after the information policy is implemented. There is, however, no effect of the policy on iodine nor calcium levels for treated households after the policy is implemented. In contrast to folic acid, the effects of iodine on IQ and of the role of calcium on the risk of osteoporosis after pregnancy have been available to the general public since the late 80's. Also, conditional on purchasing fruits, vegetables and meats, treated households had higher folic acid intake from these categories than not treated households. Concerning the other 6 categories, there are no statistical differences between treated and not treated households. Tables can be found in Appendix A.



Notes: X-axis are quantiles. The blue line represents the mean impact. Daily folic acid availability is computed by taking the average quarter availability and dividing it by the appropriate number of days. Adult equivalent scales are taken accordingly using USDA (2010).

Figure 4: High folic acid consumers react more

Additionally I report a DID placebo analysis along with the true DID in table 6. As the policy is implemented mid 2005, I find as expected that the 2004 placebo is not statistically different from zero. I find a positive but not significant effect of the policy in 2005. The lack of statistical significance could be explained by the fact that the policy was implemented in mid 2005. After 2005 the effect is positive and statistically significant. An alternative strategy to check robustness of the effect is to implement a placebo DID on household observable demographics: they should not change with the policy. Table 7 displays 5 of such DID. No observed demographic displayed a significant coefficient at the 10% level.[25]

5.2 Structural form results

Table 8 reports on the demand estimates for nutrients. An observation is on the household-department-quarter level. The dependent variable is the same across all regressions and corresponds to the household expenditure per category on a quarter. Nutrients included are: (1) macro nutrients such as fat, fibres, carbs, proteins and sugar; (2) micro nutrients such as, folic acid, iron, iodine and calcium.[26] Each explanatory variable corresponds to the contribution share of each category to the total availability of a nutrient for a household in a quarter.

The first three models present estimates from a fixed effects OLS regression. All regressions include household category and category-department-quarter fixed effects. Model (8) includes the additional category "supplements" that accounts for the possibility of households to purchase folic acid supplements. Identification comes from the correlation

[25]Two series of robustness checks are performed in Appendix A. First, I examine below whether there is evidence that the identifying assumption that the evolution of the treated in the control group would have been smaller than that of the treatment group did occurred. Second, I compare the evolution of intakes in folic acid from households that have different fertility incentives but are not treated. This is done to measure to what extend I observed a lower bound due to bias in the definition of my controls.

[26]The structural model uses the dependent variable of the reduced form analysis to construct the explanatory variable.

between household-category nutrient content shares and expenditure. Not all coefficients are positive, but all are significant. Folic acid coefficient is positive and significant across the three specifications. Models (7) and (8) allow for folic acid to depend on treatment status, before and after the policy was implemented. Treated households after the policy have stronger preferences for folic acid. Controlling for supplements increases the impact of the policy on treated households.

The last two columns control for endogenous nutrient shares. Model (9) instruments are the average nutrient contents of products bought in a quarter by households going to a same in a retailer on the same day of the week. The instruments capture the category-retailer-day variation in consumers' choice set.[27] Model (10) instruments uses an additional source of variation: each consumers' choice set varies per category. The nutritional content shares for each household is used as an instrument. Given the level of aggregation of my nutritional data, the variation of model (9) instruments is mostly picked up by the large set of fixed effects as can be seen from the first stage F-statistic, while models' (10) instruments keep their explanatory power. Nevertheless, the information policy impact on treated households preference for folic acid is robust across specifications even when controlling for preference changes on other micro-nutrients.

It is possible to compute the lower bound of the willingness to pay (WTP) that of a pregnant household for the information provided by the policy, and to compute as well the implied value per statistical life (VSL). Let β_{fol} denote the coefficient identifying the lower bound of the causal effect of the policy on preferences:

$$VSL = \left.\frac{dr}{dw}\right|_{r=0} = \frac{WTP}{r} = \frac{\beta_{fol}}{r} \tag{10}$$

where r is the risk reduction and w is wealth. To have a 40% risk reduction an individual would have to increase their daily intake by 400μg, for a period of 4 months. For a linear dose-response function the risk reduction of a 1μg would be $r = \frac{0.6}{1000} * \frac{1}{400*4*30}$. The corresponding VSL would then be of at least €17 million. The VSL found in this paper is similar in scale to that found in the VSL literature (Hammitt & Haninger, 2010).

6 Conclusion and discussion

This paper investigates the effects of the french mid-2005 folic acid advisory on purchase and preferences. It sets up a quasi-experimental setting to measure the impact on consumption using a reduced form approach, as well as a structural model to measure changes in preferences. It exploits the variation in the usefulness of folic acid information between households: households that are conceiving or want to conceive a child use it, while those that are not conceiving do not. Two methods are used to investigate different aspects of the campaign: (1) a reduced form approach dealing with changes in nutrient availability from the purchased basket; (2) a structural approach that focuses on household preferences for nutrients exploiting choice set and product specific variation over all product categories and folic acid supplementation.

Results suggest that preferences and availability for at-risk households increased as a consequence of the information policy. The structural model permits the computation of a value per statistical life of at least € 17 millions. Results are robust in several dimensions. A potential objection to this finding is that an increased level of folic acid availability is only capturing a substitution effect between in-household and out-household food consumption.

[27] In France not all retailers are open on Sundays, these instruments use this type of variation.

Yet, data suggests that NTD prevalence rates decreased after 2005. In could be in part due to the increase from 0.01% in folic acid supplementation at the correct window in 1995, to 14% in 2010, which is consistent with an increase of awareness and the findings in this paper. Also, the general increase in folic acid intake between 1999 and 2007, as a spill over from the general fruits and vegetables campaign also could explain the lower prevalence.

Can France do better? Public health government interventions are economically justified under the premise of a market failure. As suggested by Griffith et al. (2014), public health through food is better accomplished by reformulation of products than by correcting the information gap of consumers. More than 60 states worldwide have fortified staple foods to decrease NTD prevalence. Fortification of foods with a vitamin is uncontroversial if are no negative secondary effects. In the case of folic acid there is epidemiological evidence of possible harm to a part of the population. This controversy has stopped all fortification efforts in France. These interventions constitute a corner stone of paternalistic policies implemented by public health officials. They are effective and efficient in fulfilling the basic nutritional needs of a large part of the population. If all staples are fortified with unnatural quantities of nutrients, there is no possibility to opt out. Fortification policies are in this sense coercive. A formal risk-benefit analysis should be done in France, assessing different interventions to reduce the prevalence even further.

Table 1: Summary Statistics treatment households

	Before		After		
	Treatment	Control	Treatment	Control	Diff & Diff
Age	30.57	36.59	30.69	36.3	-0.324
	(4.37)	(7.37)	(4.7)	(7.62)	(0.214)
BMI	23.52	23.73	24	24	0.21
	(4.55)	(4.90)	(4.72)	(4.86)	(0.26)
Income	2459.45	2210.7	2829.86	2532.89	26.50
	(1048)	(1069)	(1146)	(1234)	(51.87)
First Child	0.33	0.23	0.34	0.23	0.011
	(0.071)	(0.062)	(0.072)	(0.061)	(0.0198)
College	0.37	0.23	0.33	0.27	-0.0254
	(0.48)	(0.42)	(0.47)	(0.44)	(0.0215)

Note: Only households where women are the persons in charge of reporting purchases, aged between 18 and 50 years old are included. The first 4 columns display the standard deviations in parenthesis, while the last column display the standard errors.

Table 2: Definition of macro-categories

Name	Main items
Fruits	fresh, canned or frozen fruit
Vegetable	fresh, canned or frozen and starchy food
Grains	flour, cereals, pasta, rice, couscous, breakfast cereals and bread
Dairy	milk, cream, cheese, and yogurt
Meats	beefs, pork, lamb, veal, poultry, as well as bacon, ham, sausage eggs and all fish and seafood, whether fresh, smoked, frozen or canned; nuts
Fats	oils, butter, margerine, and lards
Sweeteners	sugar, fruit syrups, honey, artificial sweeteners, fruit juices
Drinks	sodas, water coffee, tea and other beverages
Prepared foods	all commercially prepared items: sweet savory, frozen, canned or deli

Table 3: Average expenditure and quantities per category

	Expenditure in €/per./day	Quantities in kilos/person/day			
		Before		After	
		Treatment	Control	Treatment	Control
Fruits	0.142	0.058	0.062	0.085	0.082
Vegetables	0.24	0.102	0.107	0.122	0.117
Grains	0.494	0.106	0.112	0.119	0.126
Dairy	0.617	0.292	0.287	0.265	0.263
Meat	0.814	0.088	0.088	0.102	0.097
Fats	0.156	0.046	0.048	0.046	0.046
Sugar	0.042	0.015	0.017	0.016	0.016
Drinks	0.555	0.499	0.439	0.465	0.415
Prepared F.	0.598	0.132	0.127	0.141	0.134

Note: Only households where a woman is in charge of reporting purchases, aged between 18 and 45 years old are included. All variables are corrected with adult equivalent scales. Only positive quantities are used in the analysis. Daily quantities are obtained by diving the average quantities per quarter by the total number of days the household was active per quarter. Household are on average active 70% of weeks during a quarter.

Table 4: Average contribution of Dietary Folate Equivalent per category

Fruits	Vegetables	Grains	Dairy	Meats	Fats	Sugars	Drinks	Prepared Foods
0.08	0.10	0.29	0.23	0.08	0.00	0.01	0.10	0.11
(0.09)	(0.10)	(0.14)	(0.10)	(0.07)	(0.01)	(0.02)	(0.08)	(0.07)

Note: Only households where a woman is in charge of reporting purchases, aged between 18 and 45 years old are included. Results are proportions; standard deviations are in parenthesis.

Table 5: Reduced form results on daily folic acid availability

	(1)	(2)	(3)
Treatment	-6.247**	-9.253***	-8.963***
	(2.857)	(2.934)	(2.937)
Treatment X Policy	7.508**	7.153**	9.320
	(3.349)	(3.412)	(14.97)
Treatment X Policy X College			-12.56***
			(4.760)
Treatment X Policy X Age			-0.605
			(0.440)
Treatment X Policy X Income			0.00673***
			(0.00196)
Treatment X Policy X First Kid			7.353**
			(3.651)
College		10.53***	11.49***
		(2.082)	(2.186)
Age		-1.048***	-0.997***
		(0.142)	(0.146)
Income		-0.00653***	-0.00701***
		(0.000794)	(0.000830)
First kid (yes=1)		-6.119***	-6.845***
		(1.599)	(1.710)
Constant	171.2***	220.9***	220.1***
	(1.233)	(5.312)	(5.458)
Observations	83212	83212	83212
Year FE	Y	Y	Y

Note: Dependent variable is average daily folic acid availability per quarter adjusted with adult equivalent scales (USDA). All regressions are based on households where women are the persons in charge of reporting purchases, aged between 18 and 45 years old are included. Robust standard errors are in parenthesis. *** significant at the 1% level;** significant at the 5% level;* significant at the 10% level.

Table 6: Common trend assumption

	(4)	(5)
Treatment	-7.094**	-10.68***
	(3.533)	(3.630)
Treatment X 2004	1.749	2.903
	(4.785)	(4.896)
Treatment X 2005	4.900	5.224
	(4.770)	(4.865)
Treatment X 2006	9.718**	9.916**
	(4.548)	(4.650)
Treatment X 2007	10.72**	10.87**
	(4.810)	(4.875)
Constant	147.7***	170.5***
	(0.992)	(5.475)
Observations	83,212	83,212
Year FE	Y	Y
Household characteristics (HHC)	Y	Y

Note: Dependent variable is average daily folic acid availability per quarter adjusted with adult equivalent scales (USDA). All regressions are based on households where women are the persons in charge of reporting purchases, aged between 18 and 45 years old are included. Household characteristics include age, income, first child and education. Robust standard errors are in parenthesis. *** significant at the 1% level;** significant at the 5% level;* significant at the 10% level.

Table 7: Placebo DID on observable characteristics

	BMI	College	Income	Age	First Child
Demographic	-0.264	0.143***	229.2***	-6.720***	-0.220***
	(0.227)	(0.0185)	(45.31)	(0.195)	(0.0206)
Demographic X Policy	0.0604	-0.0254	26.50	-0.324	0.0121
	(0.232)	(0.0215)	(51.87)	(0.214)	(0.0246)
Constant	23.76***	0.271***	2,229***	37.72***	0.701***
	(0.0830)	(0.00671)	(15.98)	(0.105)	(0.00699)
Observations	88,608	102,536	101,376	102,536	102,536
Year FE	Y	Y	Y	Y	Y

Note: Dependent variable is demographic. All regressions are based on households where women are the persons in charge of reporting purchases, aged between 18 and 45 years old are included. Robust standard errors are in parenthesis. *** significant at the 1% level;** significant at the 5% level;* significant at the 10% level.

Table 8: Results on demand estimates: preferences for nutrients

	(6)	(7)	(8)	(9)	(10)
Treatment X Policy X Folic acid		0.136*	0.339***	0.219*	0.364***
		(0.0808)	(0.0877)	(0.113)	(0.117)
Treatment X Folic acid		-0.102	-0.0480	-0.429***	-0.587***
		(0.0777)	(0.0835)	(0.102)	(0.106)
Policy X Folic acid		0.0166	0.0184	0.183**	0.197***
		(0.0185)	(0.0189)	(0.0716)	(0.0689)
Folic acid	0.184***	0.174***	0.225***	0.286***	0.0791
	(0.0179)	(0.0207)	(0.0211)	(0.0678)	(0.0845)
Iron	0.285***	0.218***	0.214***	0.141**	0.0628
	(0.0258)	(0.0245)	(0.0247)	(0.0605)	(0.0755)
Iodine	-0.0453**	-0.145***	-0.146***	-0.189*	0.130
	(0.0224)	(0.0283)	(0.0282)	(0.111)	(0.114)
Calcium	0.164***	0.142***	0.138***	0.107	0.634***
	(0.0337)	(0.0334)	(0.0334)	(0.313)	(0.202)
Fat	0.225***	0.226***	0.227***	0.225***	-0.296***
	(0.00967)	(0.00959)	(0.00954)	(0.0371)	(0.0440)
Fibres	-0.0934***	-0.0944***	-0.103***	-0.217	0.275***
	(0.0275)	(0.0273)	(0.0273)	(0.246)	(0.0519)
Carbs	0.328***	0.333***	0.309***	-0.309	-0.931***
	(0.0425)	(0.0424)	(0.0415)	(0.247)	(0.0828)
Proteins	0.990***	0.996***	0.987***	1.215***	-0.0547
	(0.0744)	(0.0741)	(0.0738)	(0.136)	(0.107)
Sodium	0.0490***	0.0491***	0.0469***	-0.132***	-0.169***
	(0.00611)	(0.00614)	(0.00608)	(0.0364)	(0.0283)
Interact. w.o. micronutrients	N	Y	Y	Y	Y
Category-dept-quarter FE	Y	Y	Y	Y	Y
Household-categry FE	Y	Y	Y	Y	Y
Supplements	N	N	Y	Y	Y
IV DGN	N	N	N	Y	N
IV shares	N	N	N	N	Y
Weak IV				2.03	131
Observations	828,615	828,615	828,615	828,286	828,286

Note: Only households where women are the persons in charge of reporting purchases, aged between 18 and 45 years old are included. Robust standard deviations are in parenthesis. *** significant at the 1% level;** significant at the 5% level;* significant at the 10% level.

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Appendix

A Robustness checks

A.1 Were households informed before the policy?

The identifying assumption that the evolution of the treated in the control group would have been smaller than that of the treatment group is sufficient to estimate the impact of the policy. I examine below whether there is evidence that this occurred.

For this analysis, I focus on households that conceive a child. Consider the following relationship between folic acid consumption and quarter lead and lags with respect to the quarter of estimated conception:

$$z_{it} = \kappa + \sum_{l=-7}^{7} \lambda_l d_{il} + \sum_{l=-7}^{7} \tau_l d_{il} \times \mathbb{1}_{year>2004} + X_{it}\beta + \delta_t + \tilde{\epsilon}_{it} \tag{11}$$

where d_{il} is a dummy that indicates whether individual i is on the l-th quarter away from their conception quarter. I am interested in analysing how the policy influenced consumption around the period of conception. I focus on an interval of -2 years and +2 years around the estimated conception of the baby. Each coefficient τ_l can be interpreted as the estimated impact of the policy on a given quarter around the conception.

There is a testable prediction on the pattern of coefficients. If individuals were informed both before and after the policy then coefficients τ_l should not be statistically different from zero. Figure 5 and 6 plot the λ_l and τ_l coefficients, respectively.[28] Each solid line corresponds to the estimated coefficients of the dummy for being on the l-th quarter away form conception (a 95-percent confidence interval is plotted by dashed lines). The λ_l coefficients fluctuate around zero while τ_l coefficients are positive and significant around the period of conception. This pattern suggest that before the policy households were not informed about the the effects of folic acid. As expected, the policy had its highest impact around the period of conception. These figures show that the identification strategy is reasonable and that the policy had an effect on the consumption of folic acid.

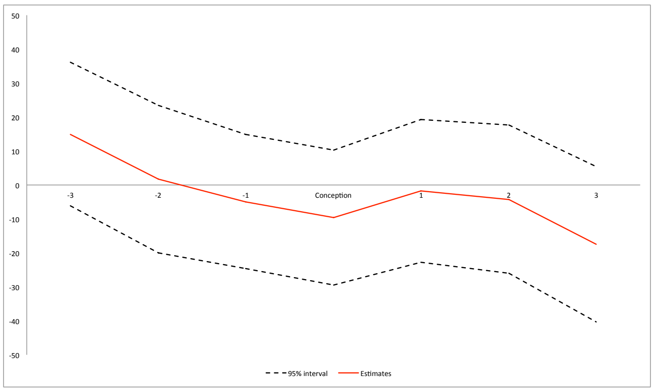

Figure 5: Folic acid intake around quarters of conception: Before policy

[28]Estimates are obtained using 7 leads and lag, but I only plot 3 leads and lags for presentation purposes.

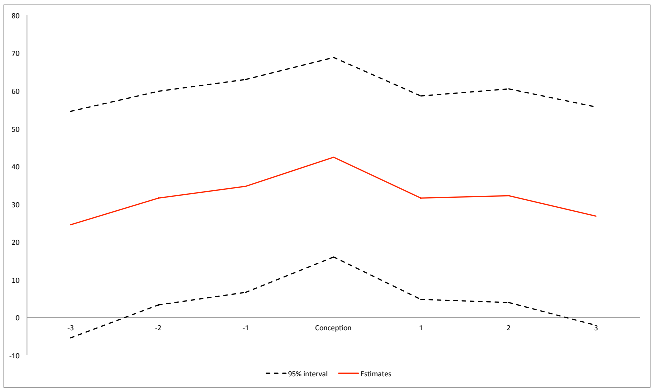

Figure 6: Folic acid intake around quarters of conception: After policy

A.2 Sex-mix as instrument for fertility

Table 9 reports on the sibling-sex mix composition on fertility similar to those of Angrist & Evans (1998). The panel looks at the gender preferences by reporting on the probability of a household to have a third child conditional on the gender of the first two children. The first row reports the sample size of having one boy and one girl, as well as both of the same sex. Conditional on the sibling-mix, the second row reports on the probability of having a thirds child, while the last row reports on the probability of conceiving during a year.

Data suggests that women with two girls or two boys are more likely to have a third child. Women that had a boy and a girl correspond to 49.6% of household with at least two children. Their probability of having another child is 29.3% compared to 36.2% for women that had either two girls or two boys. It implies that women with two children of the same sex is 24% more likely to have a third child.

Suppose that household's A first two children are boys. Data suggests that compared to household B, which has a girl and a boy, household A is more likely to be planning to have another child. Nevertheless, the conception probability of household A and household B on a specific year does not depend on the sex of the first two children. Siblings randomly assigned sex make it possible to select the sub-sample of households that are less likely to have a child a controls.

Figure 7 displays the folic acid intake for households with at least two children that did not conceive over tne period of observation. There is no difference after the policy between the availability among both sub-groups. This suggests that controls are not as dirty as expected, and that the effect is not biased downward.

A.3 Micro nutrients and product characteristics

I check the effect of the policy on other micro nutrient availabilities: iron, iodine and calcium. These micro nutrients are also an integral part of a pregnant women diet, though PNNS objectives only mentioned increasing the folic and iron status of pregnant women (PNNS dossier de presse 2005, p.21). Iron is needed to prevent anaemia during pregnancy and it is advised to have iron-intensive food products during, and after the pregnancy. Low levels of iodine during the first trimester of the pregnancy have been linked with decreased IQ of the offspring. Calcium is needed to reduce risk of osteoporosis. Table 13 display results. Treated households consistently have lower levels of nutrients than non treated

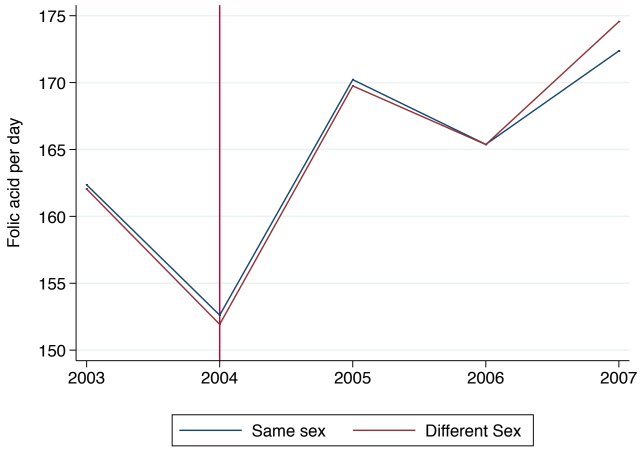

Figure 7: Folic acid intake for control group with at least 2 children: Same sex vs. Different sex

Table 9: Fertility and sex mix

	Sample of observation	Fraction that had another kid
One boy, One girl	0.496	0.293
		(0.001)
Both same sex	0.504	0.362
		(0.001)
Difference (2)-(1)		0.07***
		(0.014)

Note: Only households where women are the persons in charge of reporting purchases, aged between 18 and 50 years old are included. Results are consistent with Angrist & Evans (1998).

households. According to the iron regression, daily iron availability increases for treated women after the information policy is implemented. There is, however, no effect of the policy on iodine nor calcium levels for treated households after the policy is implemented. In contrast to folic acid, the effects of iodine on IQ and of the role of calcium on the risk of osteoporosis after pregnancy have been available to the general public since the late 80's.

Also, conditional on purchasing fruits, vegetables and meats, treated households had higher folic acid intake from these categories than not treated households. Concerning the other 6 categories, there are no statistical differences between treated and not treated households. Table 14 display results.

B Data: Constructing the conceiving/pregnant group

It is possible to construct a measure of when a household is conceiving a baby using the birth date of babies. Let t be the year of birth of the baby, I define the variable "conception" as the year previous to birth (year $t-1$) and the variable "birth" as the year of birth. In average conception is 9 months previous to birth, so it is possible that the year of birth is the year of conception. I consider that a household is treated if the household is either during the year of conception or birth. Figure 8 provides a graphical illustration of how I define the treatment.

Figure 8: Defining treated households

C Adult equivalence

I construct a household equivalence scale based on daily caloric requirement of all household members divided by 2,500. Daily Caloric Requirement of individual household members is given in Table 10.

Table 10: Caloric Needs by Age and Gender

Age	**0-1**	**2**	**3**	**4-5**	**6**	**7-8**	**9**	**10**
Male	700	1000	1400	1400	1600	1600	1800	1800
Female	600	1000	1200	1400	1400	1600	1600	1800
Age	**11**	**12-13**	**14**	**15**	**16-25**	**26-45**	**46-65**	**65+**
Male	2000	2200	2400	2600	2800	2600	2400	2200
Female	1800	2000	2000	2000	2200	2000	2000	1800

Source: USDA 2010.

D Prevalence rates in France

Data from prevalence rates are taken from EUROCAT (2015). [29] Only registries from Paris and Strasbourg are taken. Paris registry is the only registry in France that has

[29] Data are free an available at www.eurocat.eu

data from 1981 to 2012; Strasbourg has data from 1982-2007. Table 11 reports on results from 3 empirical implementations. Model (1) considers a break in 1995, date at which the U.S. announced their mandatory folic acid fortification policy, until 2005 when the French government started their massive information policy campaign. Model (2) considers a break starting in 2000 when several small private advisory initiatives in France were born. Finally, model (3) considers a model with an underlying trend allowing for a break in 2005. All models capture a positive trend before the advisory campaign in the middle of 2005 and a negative trend after.

Table 11: Prevalence rates in France from 1981 to 2012

	(1) Levels 1995	(2) Levels 2000	(3) Trend
1995-2005	2.874***		
	(0.612)		
2006-2012	1.261		
	(0.817)		
2000-2005		2.796***	
		(0.738)	
2006-2012		0.777	
		(0.841)	
After 2005			12.88
			(9.329)
Trend			0.224***
			(0.0403)
After 2005 X Trend			-0.571*
			(0.330)
Paris (if =1)	0.391	0.373	0.545
	(0.567)	(0.598)	(0.545)
Constant	10.80***	11.30***	8.935***
	(0.489)	(0.477)	(0.673)
Observations	58	58	58
R-squared	0.294	0.215	0.379

Notes: Standard errors are clustered to the household level. Standard deviation in parenthesis. *,**,*** are significant at p<0.1, p<0.05 and p<0.01 confidence levels. All regressions include data from registries of Paris and Strasbourg taken from EUROCAT (2015) from 1981 to 2102.

E What has been done in France

The history of this combined policy dates back to 1995, when a private recommendation published by the French Pediatric Society (FPS) advised pregnant women to take a daily dose of 200 micrograms of folic acid supplements. The recommendation also urged women of child-bearing age to increase the intake of folate. By 1997 the National College of Obstetrics and Gynaecology followed up in the recommendation.

By 1999, the DGS organized a committee of experts to single out a national recommendation, which was issued in August 2000. The national recommendation reminded doctors to systematically supplement any woman who wanted to have children with a daily dose of 400 micrograms of folic acid starting two months before conception until two months after conception. The government committed to pay up to 65% of the costs of the supplements under the sole condition of having a prescription. No efforts were made to encourage or aid in opting for a folic intensive diet to the general public.

In 2003 a folic acid fortification pilot program was designed for the french region of Alsace. Its mission was to evaluate the impact of introducing fortified flour. The project failed because of strong opposition due to its potential side effects. Nonetheless, the debate is still on the table at a European level with decision makers asking for more research on the potential benefits or harm of fortified food in order to make an informed decision.

The 2004 bill comprised general objectives targeting the population as a whole, as well as specific objectives targeting small groups of individuals. Table 15 displays the objectives of the Plan National Nutrition Santé (PNNS).

F Facts about pregnancies in France

An important aspect is that in France, less than 15% of births are not desired (HCF, 2012).[30] The low percentage of unwanted births is explained could be explained by voluntary termination of pregnancies; roughly, 1 over 5 pregnancies in France are terminated.

Another important aspect is to assess how many households who want a child are not able to conceive. Table (12) reports on the intention to have a child in 2005 and actual births in 2008. The survey was administered by the Etude des relations familiales et intergénérationnelles, ERFI, which interviewed couples where women were less than 50 years old, and where both members agreed on having a child. Form the entire sample, 28% stated wanting a child and more than half did effectively had a child by 2008. Even though the sample in the ERFI survey is restricted to couples, it is important to keep in mind that within the data used in this paper, there could be households that do want to have children and cannot, as well as households that do not want to have children but do.

Table 12: Intentions to have a child and realization

Intention to have a child	Answered in 2005	Had a baby 2005-2008 conditional	unconditional
Yes	15%	65%	9.75%
Probably yes	13%	55%	7.15%
Probably not	5%	32%	1.60%
No	67%	6%	4.02%

Source: Etude des relations familiales et intergénérationnelles (ERFI). Couples where the women was less than 50 years old, and where both members agreed on having a child

[30] Rates in 1995; New data will be available soon in the new HCF, expected on 2015. Not desired births include children that were not properly planned.

G Folic acid a controversial molecule

Human beings cannot synthesize vitamin B9 and need to acquire it from external sources. The principal natural source of it in the daily diet comes from vegetables and fruits and to a minor extent from grains, cheese, eggs, and liver of different animals. Yet, folate bio-availability from such sources is not fully recovered by the human body. Actually, the intestine track can only absorb between 50 to 60% of the total intake.[31] Folic acid, being a monoglutamate molecule, it is better absorbed than its natural occurring counterpart, which is a polyglutamate molecule. There is, however, need for more research on the bio-availability of natural folates in food. McNulty et al. (2004) stress an important issue: "concerning the lack of accurate data on folate bio-availability from natural food sources. [...] The poor stability of folates in foods under typical conditions of cooking can substantially reduce the amount of vitamin ingested and thereby be an additional factor limiting the ability of food folates to enhance folate status". Therefore, it is important for a country that does not rely on mandatory food fortification to correctly assess the levels of folates in natural foods to provide quantifiable data on which to base food policies.

Deficiency of vitamin B9 has been identified as one of the determinants of serious birth defects (Llanos et al 2007; Sharma et al. 1994). The two most common birth defects are spina-bifida and anencephaly. These NTD occur when the neural tube does not close properly so that the spinal cord is not fully covered. The closing happens around 24 days after conception, i.e. before the woman realizes that she is pregnant. In case of an anencephaly the child dies immediately after birth, whereas in case of a spina-bifida the child often survives but is often impaired by disabilities such as paralysis and other physical handicaps. The main risk factors that have been identified are low maternal intake of folic acid, diabetes, use of valporic acid or carbamazepine, obesity and impaired vitamin B12 status (Rouget 2005).

Recent studies (Ingeborg et al. 1999; Wendy et al. 2000) show that an average daily intake of 400 μg of folic acid two months before and one month after conception reduces the risk of a foetus to suffer a NTD between 40 to 80%. Folates are an important element for the metabolism of amino acids and nucleic acids. They play a crucial role in the replication of DNA and RNA.[32] A lack of folic acid causes the mitosis to happen at a lower rate, which is particularly bad during periods of strong cellular division activity (pregnancy or early childhood). Its critical role in the development of the neuronal connection is unquestionable (Eichholzer et al. 2006).

The effectiveness in reducing NTD prevalence is not the only positive health aspect of folic acid. A recent meta-analysis, (Xiaobin et al. 2007) has shown that folic acid supplementation can effectively reduce the risk of suffering a stroke in primary prevention. Another meta-analysis (Wald et al. 2006), supports the idea that folic acid supplementation decreases the risk of cardiovascular diseases. The intuition is that raised levels of serum homocysteine are associated with higher risks of ischaemic heart diseases and strokes. What folic acid supplementation does is to help decrease the levels of homocysteine in the human body, hence decreasing the risk associated to both stroke and heart disease. Folic acid is also associated with bowel cancer risk reduction. A recent meta-analysis of 27 studies found that high folate intake was associated with a 15% reduction in bowel cancer risk (Jentink et al. 2008). Additionally, higher intake levels of folic acid have been related to lower breast cancer risk in women (Ericson, 2007). Finally, decreased

[31] This is the reason why dietary folate equivalent is used

[32] "Folate is needed to carry one-carbon groups for methylation reactions and nucleic acid synthesis the most notable one being thymine, but also purine bases" (Figuereido et al, 2009).

risks levels regarding pancreatic, oesophageal and gastric cancer have been found (World Cancer Research Fund, 2007).

It is important to stress that high doses of folic acid are suspected to have negative health effects on the population. There is an ongoing debate in the epidemiological literature on whether folic acid is more harmful than beneficial to human health (Kim et al. 2004; MRC 1991; Molloy 2005; Wald et al. 2006). High levels of folic acid are suspected to be one of the primary causes of colorectal cancer. This is due to the fact that folic acid helps the development of cancerous adenoma -the precursors of cancer cells. A meta-analysis by Fife et al. (2011) concludes that taking folic acid supplements for less than three years has no effect on adenoma recurrence overall, while taking it over more than three years revealed an increase in the risk of colorectal adenoma, especially on advanced adenoma. This suggests that folic acid might be linked with a higher risk of colorectal cancer.

Colorectal cancer is not the only harm that folic acid is suspected to cause. Another study (Ebbing et al. 2009) highlights that folic acid could be associated with increased lung and haematologic cancer risk.

Another potential drawback of folic acid is that it masks the effects of low levels of vitamin B12 in the body. Due to its role in the development of red blood cells, deficient levels of vitamin B12 will eventually lead to pernicious anaemia. Yet, the effects will not be noticed since folic acid masks anaemia while not correcting the negative neurological effects, principal manifestation of pernicious anaemia. The US National Institute of Health found that "high serum folate levels not only might mask vitamin B12 deficiency but could also exacerbate the anaemia and worsen the cognitive symptoms associated with vitamin B12 deficiency" (NIH, 2010).

Evidence seems to suggest that the effect on human health has an inverted U-shaped. When the human body does not have enough folic acid, the risk of developing cancer, of suffering a stroke or heart attack, increase. Once the folic acid level is too high, other problems occur: masking B12 deficiencies; higher risk of developing different types of cancer. A natural question that arises is, how much is too much? (Verhoef, 2011). The answer to this question falls out of the scope of this paper, nevertheless it is of crucial importance if a government is considering a mandatory fortification policy (Larsson et al. 2007).

Table 13: Results on other micronutrients

	Folic acid	Iron	Iodine	Calcium
Treatment	-9.253***	-0.317***	-0.769	-5.027
	(2.934)	(0.122)	(1.317)	(14.09)
Treatment X Policy	7.153**	0.307**	-0.0816	-6.653
	(3.412)	(0.144)	(1.517)	(15.86)
College	10.53***	-0.186**	0.853	42.01***
	(2.082)	(0.0789)	(0.847)	(9.177)
Age	-1.048***	-0.0550***	-0.766***	-6.831***
	(0.142)	(0.00598)	(0.0627)	(0.662)
Income	-0.00653***	-0.000305***	-0.00357***	-0.0315***
	(0.000794)	(3.15e-05)	(0.000347)	(0.00362)
First child	-6.119***	-0.262***	-0.348	3.588
	(1.599)	(0.0686)	(0.699)	(7.452)
Constant	220.9***	9.586***	117.2***	1,179***
	(5.312)	(0.227)	(2.403)	(24.99)
Observations	82,213	82,213	82,213	82,213
Year FE	Y	Y	Y	Y
Household characteristics	Y	Y	Y	Y

Note: Dependent variable is average daily folic acid availability per quarter adjusted with adult equivalent scales (USDA). All regressions are based on households where women are the persons in charge of reporting purchases, aged between 18 and 45 years old are included. Robust standard errors are in parenthesis. *** significant at the 1% level;** significant at the 5% level;* significant at the 10% level.

Table 14: Results on categories

	Fruits	Vegetables	Grains	Dairy	Meat	Fats	Sugar	Drinks	Prepared F.
Treatment	-1.372*	-2.024**	-5.457***	-0.527	0.218	4.46e-05	-0.614***	-1.005	-0.607
	(0.709)	(0.904)	(1.560)	(0.737)	(0.443)	(0.00648)	(0.160)	(0.658)	(0.431)
Treatment X Policy	1.984**	1.876*	1.963	-0.0935	0.979*	0.00303	0.137	0.302	0.623
	(0.971)	(1.083)	(1.705)	(0.838)	(0.510)	(0.00729)	(0.180)	(0.738)	(0.504)
Constant	16.90***	21.15***	64.12***	48.09***	14.00***	0.211***	8.195***	34.76***	37.03***
	(1.636)	(1.583)	(2.447)	(1.297)	(0.724)	(0.0110)	(0.319)	(1.109)	(0.814)
Observations	69,931	79,359	81,225	81,405	80,450	77,979	42,961	80,676	81,228
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Household characteristics	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note: Dependent variable is average daily folic acid availability per quarter adjusted with adult equivalent scales (USDA). All regressions are based on households where women are the persons in charge of reporting purchases, aged between 18 and 45 years old are included. Household characteristics include age, income, first child and education. Robust standard errors are in parenthesis. *** significant at the 1% level;** significant at the 5% level;* significant at the 10% level.

Table 15: General and specific objectives PNNS

Objectives	Details	Targeted population
General		
Increase consumption Fruits and Vegetables	Reduce by 25% share of individuals consuming only 1.5 portions	All
Increase intake on calcium	Reduce by 25% share of individuals having intakes below recommended standard	All
Reduce the average proportion of lipids	Less than 35% of caloric intake, while reducing even more satured fat	All
Increase the consumption of carbohydrates	Account +50% of daily energy intake (starchy foods); simple sugars >25%;increase dietary fibre intake by +50%	All
Reduce alcohol intake	by 20%, in order to reach a goal of less than 8.5l/year/person.	All but alcoholics and pregnant women
Reduce the mean blood cholesterol level	Reduce by 5% LDL-cholesterol level	All adults
Reduce average systolic blood pressure	Reduce by 2-3 mm of mercury	All adults
Reduce overweight and obesity	Reduce by 20% overweight and obesity prevalence	All
Increase physical activity	Increase by 25% share of individuals doing 0.5h of sport per day	All
Specific		
Reduce salt	to less than 8g/person/day	All
Reduce Iron inefficiencies	in women of reproductive age to below 3%	pregnant women
Increase folate blood levels	Increase intake by 400μg daily intake on relevant period	pregnant women
Promote breast feeding		pregnant women
Increase calcium, vitamin D and reduce iron deficiencies	to less than 2%.	Children, seniors
Prevent, screen and restrict malnutrition		Seniors, restrictive diets, poor
Raise awareness on food allergies		All

Source: Plan National Nutrition Santé 2010.