Heterogeneity on consumers' responses to a food safety related event:
The case of the 2005-2006 avian influenza

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ABSTRACT

This paper investigates people's response to a food safety scare. By contrasting the behavior of consumers of organic as well as labeled food on the one hand and consumers of conventional food on the other, we study how different types of consumers react in the short and long run to the 2005/2006 avian influenza episode. Using a non-equivalent dependent variable approach to control for internal validity threats, we find that there is a significant heterogeneity in responses according to their preferences for labeled food: Consumers of labeled food react to the event and exhibit a significant change in their behavior by reducing their chicken consumption until the authorities released a statement declaring the safety of eating well cooked chicken, whereas consumers of conventional food do not appear to react at all in the short run. In the long run, consumers of labeled food present a full recovery on chicken consumption reestablishing it to the levels observed before the episode while the other types of consumers present a structural reduction on their consumption (relative to beef). This study may inform the response to food safety scares on behalf of managers in the food industry and policy makers deliberating suitable target groups for information campaigns dealing with the health risks in question.

INTRODUCTION

With an increasing concern for food safety and the consequences of previous disease outbreaks, one topic that has been getting more attention is the analysis of consumer's behavior when faces an episode of this nature. However, among consumers facing the same situation, multiple responses might be found depending on the consumer's characteristics: degree of risk aversion, degree of trust on the authorities (or media), asymmetries on the information, etc.

One way to differentiate types of consumers can be directly obtained from their consumption patterns. Labeling is one popular technique to increase the consumer's information about a certain product (production process, inputs being used, etc.). People buying labeled or organic food can be differentiated from people who buy standard food. When facing an epidemic event, “labeled/organic consumers” might react differently from standard consumers.

Stronger preferences for health, animal welfare, product’s quality, etc., will lead a part of the population to choose labeled products instead of standard products. The same preferences will be related with the concerns of health risks attached to the consumption of a certain product. So, a labeled consumer will have more incentives to be informed about food safety related events. Assuming that bad news have more diffusion than good news[1] (Baumeister, 2001), depending on the preferences for health, animal welfare, product’s quality, some consumers will be informed about both, news that increase the health risk (bad news) and news that decrease it (good news); others will be informed only about news that increase the health risk; and another group might not be informed at all. This information asymmetry will be traduced in heterogeneity of responses among consumers to a same food safety related event.

The first question that I find highly interesting and has not been addressed (as far as I know) is: How differently do labeled/organic-consumers react when facing an epidemic event relative to standard-consumers’ reaction? The answer to this question can be very useful for firm managers to react properly to an event of this nature, and also for shaping appropriate information campaigns by the government, to reduce the information asymmetry, and increase the effectiveness of the campaign.

I will devote this introduction, to explain the links between labeled products and animal health, since this paper is part of a research project on animal health. Secondly, I will give some facts about foodborne outbreaks and their economic impact, their effect on consumer’s decisions, and the relevance of this type of research. Then I will move to the second section of our paper starting with the description of the data and the methodologies employed. The third section will be dedicated to present the results of the analysis, and finally I will conclude.

Animal health and its relation with labeled products.

In France, different labels can be found in the food market. Some of them are product-specific (ex. 4C for coffee), and some others are available in a broad range of products (ex.

[1] This can also be thought as asymmetric costs of being informed, where being informed about bad news is easier and cheaper, while being informed about good news is harder and more expensive.

Label rouge). The objective of these labels is to disclose some information to the consumer about product characteristics that are not immediately apparent or verifiable by consumers.

For animal products the labels inform about different aspects such as the feeding, farming methods, age of slaughtering, final presentation, and shelf life. Some labels are just focused on feeding procedures, and others cover all the aspects previously mentioned.

There are some procedures that consumers may link to higher levels of animal health and welfare and that can be found as requirements for getting the certification of a label. Specifically for poultry there exist different labels in the market:

Certified chicken (Poulet certifié): It is the label with the minimum requirements regarding animal welfare, including minimum space requirements for each chicken and feed rations free of animal byproducts, leading to a higher quality product that is tested periodically.

Label Rouge chicken: Only some breeds with slower growth are eligible. Buildings with minimum space requirements for the night, and days outside on free range are two of the requirements for the label rouge. These chickens must be fed with unmedicated rations consisting of at least 75% grain and no animal products, and also they must have at least 81 days old at slaughtering.

Organic chicken (AB label): These chickens are raised without any synthetic inputs, and fed a ration made up of certified organic grains and soybeans grown without chemical fertilizers or herbicides. They must be provided with a free-range access. These are the chickens with the best standards in terms of mobility and feeding.

So in general labeling might be seen as a policy that encourages the disclosing of information regarding the welfare of animals that finish as final products in the food market.

One popular belief is that organic food is safer than conventional food. This belief is fueled by the prohibition of pesticides and chemicals in raising organic food. However, the risk from pathogenic microorganisms on organic foods is not clear and not very considered by consumers in USA (Crandall, 2009). Even if this idea is not true, consumers may believe that organic and labeled food is safer than conventional one, and this will impact their behavior regarding to consumption patterns when facing a risky event.

There are different determinants that lead the consumers to purchase labeled products. For example, in USA consumers seem to prefer eco-labeled and organic apples rather than regular apples due to the characteristics of these products regarding food safety and environmental quality (Loureiro, 2001). Regarding animal products, there is evidence pointing that humane treatment of animals has the highest level of support among all those standards that consumers are interested in supporting through their purchases (Howard, 2006).

Some efforts have been done to identify the characteristics of people who buy organic products in the US. A logistic regression analysis suggests that humane treatment is more supported by women, European-Americans, younger people and organic purchasers, covering an important share of the food market (Howard, 2006). Another study in the U.S. finds that organic consumers are a bimodal population consisting of one group in their 20s and a second composed of aging baby boomers, similar when analyzing the organic consumers by income distribution, with young parents rebudgeting to pay higher prices for organic foods and older Caucasian families with household incomes in excess of $80,000 (Crandall, 2009).

Eco-labels have had a positive response from consumers, with organic food sales increasing at a rate of 20% or more since 1990 in the US (Dimitri and Greene, 2002), and similar rates in some developed countries in Europe and also in Japan (Kortbech-Oleson, 2003).

Differences between organic and conventional buyers have been found. Among these we have that organic buyers have significantly higher risk perceptions than do conventional buyers for food safety hazards associated with conventionally grown produce and organic buyers also perceive significant risk reductions associated with switching to organically grown produce (Williams and Hammitt, 2000). Differently to most of the studies, this one recognizes the different risks, as pesticides residues, natural toxins, or microbial pathogens. Organic buyers are willing to pay higher prices to reduce perceived pesticide-residue risks than conventional buyers are, and also are more likely to make efforts to mitigate other ingestion-related risks with practices such as avoiding red meat and drinking bottled water (Hammitt, 1990).

<u>Foodborne outbreaks and consumer’s reaction.</u>

The fear generated by a foodborne outbreak can lead to significant losses due to the people’s reaction. Even if a disease is not transmitted through the ingestion of food, the uncertainty about an epidemic may have catastrophic consequences for some sectors. For example, the World Health Organization decided to name “H1N1” to the last big outbreak instead of pork flu (as it was originally known), as an effort to save the pork industry. Still, this sector was hard hit, reporting millions in losses due to the decision of consumers of stop buying pork meat.

According to a report prepared for members and committees of U.S. Congress (Johnson, 2010), even after a joint statement issued by the WHO, OIE, WTO and the FAO saying that "pork products handled in accordance with hygienic practices are not a source of infection", several U.S. trading partners began to implement full or partial trade restrictions on U.S. swine and pork products. The numbers reported in this document states that on average, from 2006 to 2008, U.S. pork product exports accounted for $3,312 millions by year, leading to a potential loss of $429 millions for this sector. According to the United States International Trade Commission, in 2009 U.S. experienced a 14.8% loss in exports of swine and pork, which is $632 millions, exceeding expectations (Lynch, 2010).

In France it is compulsory to report to the corresponding authorities any potential foodborne outbreak, called "toxi-infection alimentaire collective" (Tiac). Just in 2009, 1255 cases of Tiac were declared in France, affecting 13,905 persons and being the cause of 9 deaths. More than a thousand cases are reported annually from which most of them are not followed by the media, so consumers are unaware of this. However, those events that appear in the media might have an impact on the consumer's behavior.

Some research has been done about the determinants of trusting in information about food-related risks, pointing that trusted sources are seen to be characterized by multiple positive attributes (Frewer, 1996).

Many of the studies that have been carried on analyzing consumer's behavior when an event increases the risk of getting sick use a media index. The daily number of articles in the press work as a proxy for the consumer's information about this risk. This methodology has been extensively used in meat safety studies (Piggott, 2004).

When working with share's prices, the event's impact is analyzed through the computation of abnormal returns on the shares of those firms that are affected. This methodology has been used, for example, in the case of firm-specific repercussions of incidents of microbiological contamination of food (Salin, 2001).

One technique commonly employed in the studies that analyze consumers' responses, is the use of a control group. Among the results of these studies we can find a significant increase on demand for cage free and organic eggs when analyzing the effect of proposition 2 on the demand for eggs in California (Lusk, 2010) or a significant difference in the demand of fish due to information provided using laboratory and field experiments (Marette, 2008). A similar use of control and treatment groups is employed in the differences-in-differences approach that is widely used for analyzing the impact of some policy or event on the consumer's behavior (see Shimshack, 2007 and 2010).

The impact of 96' mad cow crisis on consumer behavior has been analyzed using the same data set that we will be using (Adda, 2007). The author finds evidence of a non-monotonic effect of past consumption of risky goods (beef) on current consumption behavior, so only consumers with intermediate levels of past consumption decreased their demand as a reaction to the risky event.

Regarding studies about the 2005-2006 avian influenza episode, there is a paper analyzing the response of Italian consumers to news about the episode (Beach, 2008). The authors find that for fresh poultry, sales were on average 79.8 percent of what they would have been if there had been no news about bird flu. Since this episode was a few years ago, it is not easy to find studies dealing with consumer' data that analyze the effect of avian influenza.

Consumer heterogeneity is one most relevant topics in the Business and Marketing literature (see Allenby, 1999 or Kamakura, 1997 for some examples). Managers shape their marketing strategies considering how different consumers are, and this is also considered whenever a new product is launched to the market.

Relevance of the study.

The relevance of this study includes different aspects. In terms of methodology, it is the first time (to my knowledge) that interrupted time series and changes-in-changes are combined in the same study. It is interesting how different techniques are used to analyze the effect of the same event in the short term as well as in the long term. This will allow us to have a bigger picture of our problem, understand it better, and therefore be more precise about its consequences. Also, in terms of methodology, the use of a non-compatible dependent variable approach to control for internal validity threats is not a commonly seen technique in Economics; however, it is used in other sciences and it is well suited to analyze a food-safety related event.

Considering information asymmetries as the source of the heterogeneity observed in the responses to the food safety related event, the findings of this research might be of special interest for policy makers. In this kind of events, the governments normally release some statements about the risk and the precautionary measures that people should implement. If consumers are reacting differently and this is caused by misinformation or lack of information of some group, the government should increase its efforts in order to make that the "good information" reaches that group that seems to be misinformed. The results of this study should be considered to shape the governmental information policies as effective as possible, according to the purchasing patterns of each group.

Moreover, probably the most relevant implication is for managers of firms that belong to the industry affected by the event. The importance of consumers' heterogeneity has been highlighted in the marketing and business literature. Studies like this one give the managers good elements to react properly when a food safety related event takes place in order to diminish, as much as possible, its consequences. By responding correctly and in time, adapting their inputs demand, marketing strategies, and production levels, managers could reduce significantly the adverse effects of this type of events, which in some cases can be crucial for the survival of the firm. As we will explain later, the results of the Changes-in-changes approach provide important information about how consumers might adjust their diet, looking for substitutes which they consider to be less risky.

Finally, different to most of the studies analyzing consumers' behavior in food safety crisis, this study goes one step forward. Such as Williams and Hammitt (2000), this study can be seen as an attempt to increase the information about the consumer of labeled products. In words of these authors, this is a relevant task considering that there are still key differences between buyer types that remain largely unknown.

DATA AND ECONOMETRIC METHODOLOGY.

A. Data

The data we will be working with is the Kantar French consumer panel (previously TNS-Secodip). This survey records the expenditures and quantities for a list of food items. The households' purchases are reported on a weekly basis, and the households' economic and socio-demographic characteristics are reported once a year. The characteristics of the purchased goods are presented in detail, so this will enable us to classify the goods in organic/labeled products or non-organic/labeled ones (see Boizot, 2005, for a full description of this database).

The data we will be using is adjusted in order to eliminate the changes on the bought quantity due to direct- and cross-price effects (See Annex 1). For the cross-price effects, we consider only the products that are used in the analysis (i.e. chicken, and the control goods), so one important remark is that we assume that changes on the price of other goods have a negligible differential effect for chicken and the control foods[2]. These adjustments are done by using estimates of direct- and cross-price elasticities of two different studies in France (Allais, 2007; Allen, 2010) which use the same dataset we are using, but over a longer period. By adjusting our dataset, we do not need to control for price effects in our analysis avoiding any endogeneity problem.

The food safety related event to which we will focus our analysis is the 2005 H5N1 avian influenza episode, which had significant consequences for the poultry industry since people were afraid of getting infected by consuming products infected with the virus. This episode had a large coverage from the media, so a huge amount of information was available to consumers.

Actually, the H5N1 avian influenza episode started in 2003 in Asia, but it was on October 6th, 2005 when some cases of avian influenza were reported in the doors of the European Union, specifically Turkey and Rumania. On February 18th, 2006 the avian influenza arrives to France when a herd of chickens were found to be infected with the H5N1 virus in the department of Ain. It was until June 19th, 2006 when France recovered the status of virus-free country. These dates will help us to identify the changes in consumption patterns.

An additional date has to be considered. On December 5th, 2005 the FAO and the WHO issued, through the International Food Safety Authorities Network (INFOSAN), a joint statement declaring that “chicken and other poultry are safe to eat if cooked properly…”. They explained that “Cooking of poultry at or above 70° C […] is a safe measure to kill the H5N1 virus in areas with outbreaks in poultry.” (INFOSAN, 2005).

For our entire analysis we will classify the households in 3 groups and analyze independently the reaction of each of these groups. We only include those households that have at least one purchase of chicken during 2005 and the groups are defined depending on the share of labeled or organic food that consumes from a basket of representative goods[3]. The

[2] This assumption can be accepted considering that in general cross price effects are quite small and we are analyzing a period with controlled inflation. The annual inflation in France ranged between 1.2% and 2.0% for the years 2005, 2006, and 2007, while the annual inflation on food products ranged between -0.5% and 1.6%.

[3] The products that were considered to create the basket are: rice, milk, oil, pasta, ready-to-go meals, chicken, ham, eggs and beef. All of them are items among the 20% most purchased goods and have different types of labels.

households are ranked according their expenditure share on labeled food and then equally distributed among each of the groups. In 2005 5,644 households bought chicken at least once, and 4,118 have at least one purchase per year between 2005 and 2007, considering those households without at least one purchase per year as unreliable data. Taking into account all these households the average expenditure share on labeled products of the representative basket is 15.7%. Now let's see each of the groups:

- Labeled/Organic-good consumers (LC): The households on this group are characterized by their high share of labeled or organic food consumption. There are 1,373 households that have been classified as LC and have an average expenditure share on labeled products of 31.41%.
- Mix consumers (MC): There are 1,373 households in this group whom expenditure on labeled or organic products represents in average 12.44% of the expenditure on the consumption' basket.
- Standard consumers (SC): 1,372 households are classified in this group and have an average expenditure share of 3.39% on labeled goods.

B. Methodology

For the analysis of the event, we will use two different approaches. The first approach will be an interrupted time series analysis using two non-equivalent dependent variables to control for internal validity threats, and weekly data. With this approach we can analyze the consumer reaction to the food safety related event in the short run.

The second method of analysis is Changes-in-changes, which is a non-parametric generalization of the traditional difference-in-differences method, but identifies the entire distribution of treatment effects. For the second method, we need to introduce small changes to the Athey & Imbens methodology (Athey, 2006), since we will be using a different type of control. For this second method the time-windows we will be using are: the first nine months of 2005 as the before-event window; and the first nine months of 2007 as the after-event window. It is important to use the same months at each time-window in order to avoid seasonal effects that could contaminate our results.

Cheese also belongs to this category, but we excluded it since the nature of their label is quite different to the one we are interested in.

A crucial aspect for both methods is to choose carefully the control good(s) in order to avoid identification issues. In both approaches, we need to control for any alternative explanation. Our problem is characterized by its global effect, which means that there is no possibility of working with non-equivalent control groups as most of the studies in the economic literature do. This is caused by the nature of a food-safety related event. Once an outbreak takes place in a country, the risk of infection increases in all the regions (although it might be in different proportions).

A non-equivalent dependent variable is "… a dependent variable which is predicted not to change because of the treatment or event being analyzed, but expect to respond to some or all of the same contextually important internal validity threats in the same way as the target outcome" (Shadish, 2002). This kind of control is recognized to be a lesser-known and underutilized design element, but in problems with global effects it can be a very useful tool.

There are multiple validity threats, defined as "reasons why an inference might be incorrect" (Shadish, 2002), such as ambiguous temporal precedence, selection, history, maturation, instrumentation, etc. A good selection of the non-equivalent dependent variable is essential for this analysis to avoid any spurious result.

Remember that, as it was explained before, the whole analysis is done with the data which has been adjusted in order to eliminate price effects from it, so we do not have to worry about this.

One advantage of the interrupted time series approach is the possibility of using more than one control. The first control must be a product which belongs to the same food-category than chicken, considering that the adjustments done by consumers due to households specific shocks (for example income shocks or the decision of becoming vegetarian) are more similar among meat products than those observed in different categories (for example fruits, or drinks), which is reflected in the size of the income elasticities. Therefore, our first control good will be beef.

However, the disadvantage of using as control a product from the same category is that, even if we are controlling for cross-price effects between both goods, we expect some kind of substitution between goods of the same category when one of them is affected by a food safety related event, i.e. the effect on chicken could be overestimate. This is why we use an additional control variable, looking for a product as neutral as possible to any event increasing the risk of consuming chicken or beef but still sensitive to household' shocks. Therefore, we will be using pasta as the second control.

An additional assumption must be stated: Households' preferences are stable over the time period being analyzed. This assumption is done explicitly to avoid the validity threat of maturation. Since the relevant window of the event is less than a year and we are dealing with adult consumers, this assumption is easy to accept.

An important remark has to be done regarding the interpretation of the results on the Changes-in-changes approach. Differently than in the time series analysis, with this methodology we cannot use more than one control good. Therefore, the results should be interpreted as the substitution effect between chicken and beef due to the food safety related event, i.e. we will analyze if there is a significant change on chicken consumption relative to beef consumption which remains in a longer period (9 months). This result could be also be interpreted as an upper bound of the change on chicken's consumption.

Last but not least, we need to properly define our outcome variable. For our analysis we need a variable that can capture efficiently the changes on chicken consumption. The first problem that arises is that in our data set the number of members in a household can change from one year to another, so we need to use per capita units so any change on the members of a household does not affect our results.

If some consumers perceive an increase on the health risk linked to a certain product, the natural reaction that we could expect is that these consumers would stop buying the product, so demand of the product will be zero. This type of reaction will definitely be reflected on the number of purchases of chicken registered by all the households at each group.

However, and given the announcements given by the international agencies stating that there is no danger of infection by consuming chicken if it is cooked following certain recommendations, there could be some consumers that do not stop consuming chicken, but only reduce their consumption since now there is an additional cost related to following the official recommendations when cooking chicken. This effect on the consumer behavior is directly captured by the total quantity of chicken purchased.

Taking into account all these considerations for the interrupted time series analysis, at each week t, we will get the per capita quantity (in kilograms) purchased by each household and then we will take the average over all the households belonging to each group. By doing this we can avoid any of the problems previously mentioned. For the CiC approach we will work with the per capita quantity purchased by each household at both, the pre-event and the post-event time windows.

Finally some remarks are worthy to mention. In the time series analysis, the fact that the purchased quantities of chicken and beef may not have the same domain does not introduce any problematic since, as we will see later, we allow for different intercepts in our regression. However, in the changes-in-changes this does impose a problematic. Since this method has been formulated having in mind the use of a non-equivalent control group, one of the few assumptions to apply changes-in-changes is that the range of the outcome for the treatment group is a subset of the control group's one. Since this is not necessarily true when using a non-equivalent dependent variable, we need to transform our series to homogenize their range. This will not affect the results of our analysis, since what is relevant in the Changes-in-changes approach is the distribution of the outcomes, and we will be using a linear transformation. However, we have to be careful when interpreting the results of this stage.

Approach 1. Interrupted Time Series Analysis

In this first stage of analysis we will follow the approach proposed by Box and Tiao (1965, 1975), which was introduce by Glass et al. (Glass, 1975) into the social sciences field. This method use ARIMA models to control for any autocorrelation of the errors.

To distinguish the data that belongs to each product we can use two dummy variables ($Chicken, Pasta$) which will be interacting with the rest of the regressor to determine the effects we are interested in. We will be using an initial time regressor (t), and four additional time regressor ($Europe, INFO, France, Free$) initialized at the beginning of each of the event's stages in order to capture any change in the consumption's trend during the avian influenza episode[4].

The two components of our regression are specified as follows:

$$y_t = \beta_0 + \beta_1 t + \beta_2 Europe + \beta_3 INFO + \beta_4 France + \beta_5 Free + \\ Chicken\{\beta_{0c} + \beta_{1c} t + \beta_{2c} Europe + \beta_{3g} INFO + \beta_{4g} France + \beta_{4g} Free\} + \\ Pasta\{\beta_{0p} + \beta_{1p} t + \beta_{2p} Europe + \beta_{3p} INFO + \beta_{4p} France + \beta_{4p} Free\} + \varepsilon_{gt}$$

[4] Different models were tested. This model was superior in terms of the goodness of fit (Adjusted R-squared) to a model considering discrete changes instead of changes in trend. A model with changes in trend seems to be more appropriate considering that information may arrive with different delays across households. A model considering both, changes in trend and intercept shifts, does not provide a better fit than our model according to an F-test.

$$\varepsilon_{gt} = AR(4) + \xi_{gt}$$

Where:

y_t = weekly per capita purchase of {beef,chicken,pasta}

t = linear time trend

$Europe$ = linear time trend starting on Oct 6th, 2005 (before this date *Europe* =0)

$INFO$ = linear time trend starting on Dec 5th, 2005 (before this date *INFO* =0)

$France$ = linear time trend starting on Feb 18th, 2006 (before this date *France* =0)

$Free$ = linear time trend starting on Jun 19th, 2006 (before this date *Free* =0)

$$Chicken = \begin{Bmatrix} 1 & for\ chicken\ consumption \\ 0 & o.w \end{Bmatrix}$$

$$Pasta = \begin{Bmatrix} 1 & for\ pasta\ consumption \\ 0 & o.w \end{Bmatrix}$$

ε_t = autoregressive error component

ξ_t = white noise error term

We also introduce dummy variables in order to capture any seasonal effect. These seasonal dummies are by periods of 4 weeks, leading to 13 periods (12 dummy variables). This regression is run for each of the three groups of consumers.

The structure of the error component captures the autoregressive dynamic effect of consumption. Since we are using weekly data, the autocorrelation structure that we consider is the autoregressive of order 4, since usually a household goes to buy food products every week, every two weeks, or every month.

Finally, we implement the Hildreth-Lu method (Hildreth, 1960) in order to take into account this structure when estimating our parameters. The estimation is done via ordinary least squares and we use the Durbin-Watson and the Ljung-Box test to confirm that the error terms are effectively white noise, so our autoregressive structure is well defined.

Approach 2. Changes-in-changes

Which is the behavior of consumers in the long term regarding the substitution between beef and chicken when a food safety related event takes place? Do consumers decide to substitute chicken with beef due to the avian influenza event? These are the type of questions that motivate the second part of our analysis. We want to check if the event has long-lasting consequences on the diet decisions, or if it is just a temporary shock with no permanent impact on the consumers' behavior, and contrast these results with those of the short term reaction.

By using this approach we are able to identify not only average effects, but the effects among the entire distribution of consumers. We can analyze if there is a significant change on the demand of chicken relative to beef, and which part of the population (at each group) is responsible for this change. Therefore we can end up with an estimation of the substitution effect between chicken and beef that remains after the avian influenza took place.

In this stage of our analysis the Athey and Imbens's Changes-in-changes estimator (Athey, 2006) is implemented. This method is a non-parametric generalization of the traditional difference-in-differences, but identifies the entire distribution of treatment effects, and not only the average effect of the food safety related event. Therefore we are able to analyze if there is a significant change on the demand of chicken and which part of the population (at each group) is responsible for this change.

The main idea behind Changes-in-changes (CiC) is that the entire distribution of outcomes for the in-risk good would experience the same changes over time as the distribution of outcomes for the out-of-risk or control good in the absence of the event. Therefore the predicted counter-factual distribution for the in-risk good in the post-event period can be estimated by:

$$\hat{F}_{x2}(s) = F_{x1}\left(F_{y1}^{-1}\left(F_{y2}(s)\right)\right)$$

Where F_{it} is the distribution of good i at period t. In this case, x is the at-risk good (chicken), and y is the out-of-risk good (beef). So the CiC estimate at any quantile q can be obtained by the difference between the actually observed period 2 outcome for the at-risk good and its corresponding predicted counterfactual outcome. Formally:

$$\Delta^{CiC} = F_{x2}^{-1}(q) - \hat{F}_{x2}^{-1}(q)$$

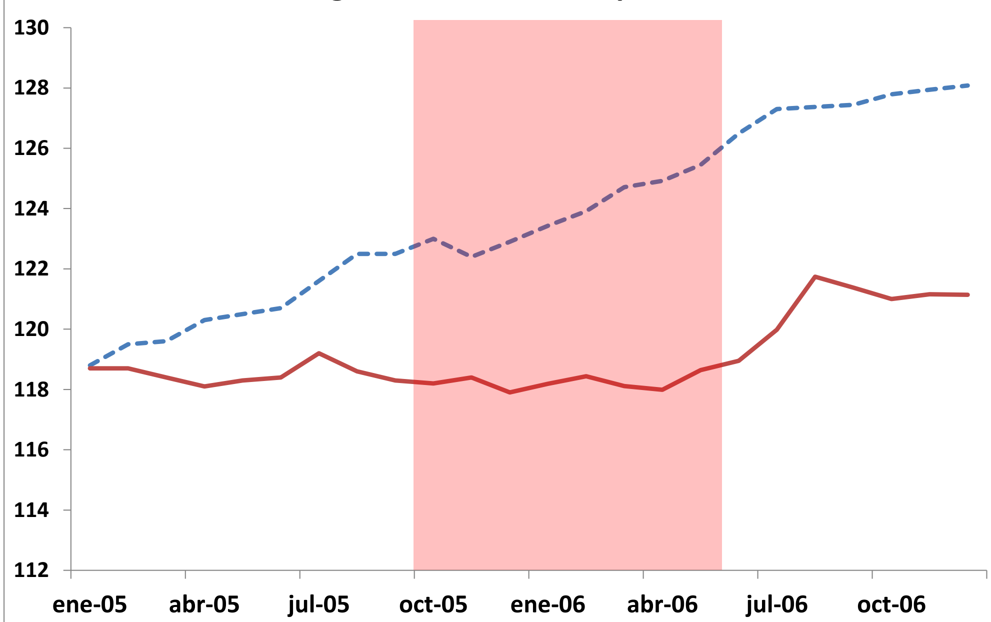
We will run the CiC estimates for each decile at each group, to see which part of the population (ranked by their per capita consumption of chicken) presents a significant change on its chicken consumption relative to beef. Finally, 95% confidence intervals are computed using simple bootstrapping.

Differently to the standard application of the CiC methodology, we have to make some changes to our series since we are using a non-compatible outcome variable to control for internal validity threats.

Similarly to what has been done with the data for the time series analysis, the first change we need to apply is the adjustment of the data due to changes in prices. The prices of both goods might change at a different rhythm and direction (see Figure 1), so we need to correct the post-event data in order to isolate the event's effect from the price effect. We will use an adjustment coefficient for each good considering the average change in price from the pre-event to the post-event period, and the price elasticities estimates such that when this coefficient multiplies the post-event data the average price effect will fade out (Annex 1).

The second change that we need is to apply a linear transformation to our data in order to normalize the domain of both goods. Since we are using a linear transformation, the interval property of the measurement system is not disturbed and the CiC methodology can be applied. The linear transformation used for each good (and group) will be to multiply by the inverse of the maximum value registered among households per capita consumption, leading to a common domain [0,1]. Once we have the results, the units in kg can be recovered by applying the corresponding inverse linear transformation, so the results will be easier to interpret.

Figure 1. Consumer's prices



Source. INSEE

RESULTS

Summary statistics for our three groups of consumers are presented in Table 1. Notice that the differences among groups in terms of variables related with their purchasing power, such as average number of cars, televisions, computers, and access to internet, are very subtle. In terms of the gender of the person in charge of shopping, there are some differences among the groups (see Table 2), with more working women in the mixed and non-labeled households, however, the academic degree obtained by the panelist of each household (see Figure 2) and the income distribution are very similar for the three types, although the labeled group is slightly richer than the other two, as the figure 3 shows.

Table 1. Summary statistics by type of household 2005

	HHL	HHM	HHNL
Number of households	1373	1373	1372
Avg number of members	2.51	2.78	2.82
Avg number of kids under 6	0.15	0.21	0.23
Avg number of kids under 16	0.44	0.56	0.64
Avg age of the panelist	54	50	47
Avg number of cars	1.47	1.50	1.47
Avg number of televisions	1.84	1.92	1.90
Avg number of computers	0.99	1.10	1.07
Internet {0,1}	0.47	0.52	0.49

Table 2.Gender of the person in charge of shopping 2005

	HHL	HHM	HHNL
Homme	5.5%	6.0%	8.5%
Femme Active	47.3%	58.3%	59.0%
Femme Inactive	47.2%	35.7%	32.4%

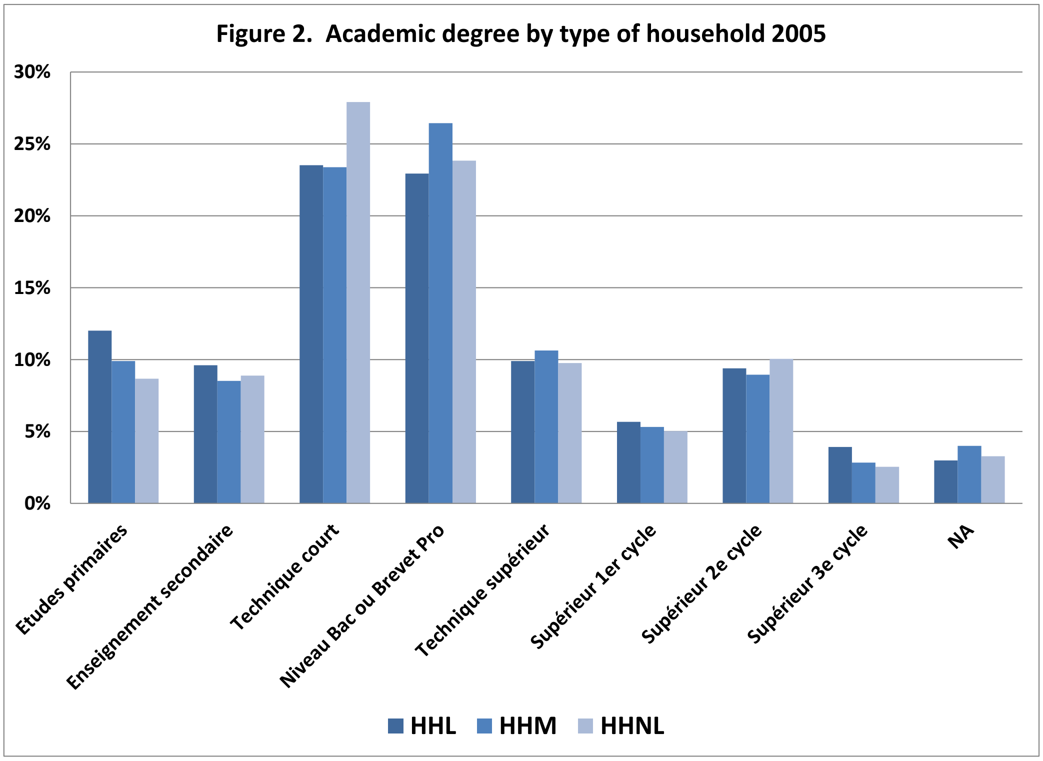


Figure 2. Academic degree by type of household 2005
30%
25%
20%
15%
10%
5%
0%
Etudes primaires
Enseignement secondaire
Technique court
Niveau Bac ou Brevet Pro
Technique supérieur
Supérieur 1er cycle
Supérieur 2e cycle
Supérieur 3e cycle
NA
HHL
HHM
HHNL

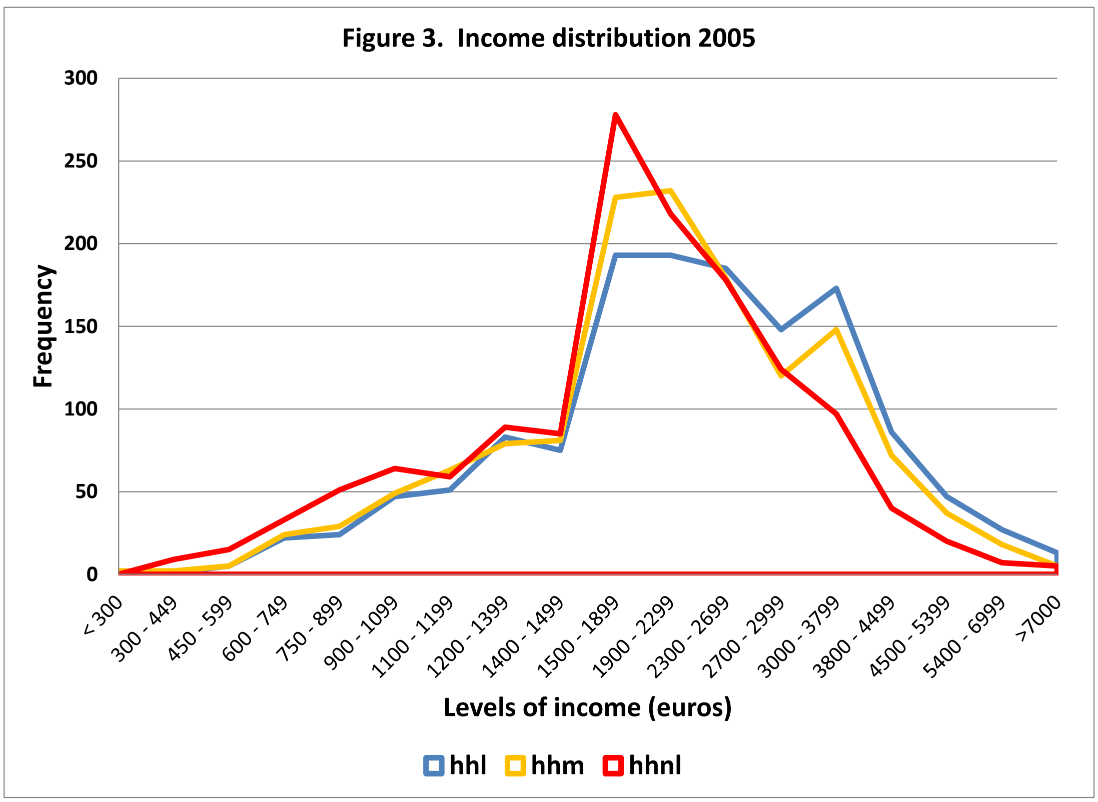


Figure 3. Income distribution 2005
Frequency
300
250
200
150
100
50
0
< 300
300 - 449
450 - 599
600 - 749
750 - 899
900 - 1099
1100 - 1199
1200 - 1399
1400 - 1499
1500 - 1899
1900 - 2299
2300 - 2699
2700 - 2999
3000 - 3799
3800 - 4499
4500 - 5399
5400 - 6999
>7000
Levels of income (euros)
hhl
hhm
hhnl

The interrupted time series analysis yields very interesting results, pointing to the heterogeneity in the consumers' responses[5]. The change in trend on chicken consumption when the avian influenza is detected in Europe (first stage of the episode) is captured by the coefficient of *Chicken:Europe*, while the coefficients of *Chicken:INFO, Chicken:France*, and *Chicken:Free* capture the changes in trend on chicken consumption when the FAO and the WHO released their joint statement, the avian influenza is detected in France (second stage) and when France recovers the free-of-disease status (last stage), respectively.

Table 3 shows that the labeled group has a significant reduction on chicken consumption's trend on the first stage of the episode (captured by the coefficient of Chicken:Europe), but it recovers (at least partially) when the FAO-WHO joint statement is released (Chicken:INFO), pointing to the effectiveness of this statement for this group. On the other hand, the mixed group seems to react only on the first stage of the episode but does not react to the FAO-WHO statement, while the non-labeled group does not react at all.

The length of the first stage is about 8 weeks, so according to our results for the labeled group there is a reduction on chicken consumption of about 1.72% relative to the quantity being consumed before the avian influenza arrived to Europe. However, with the WHO/FAO's statement, this effect is reversed. Therefore, for the weeks following this announcement there is a recovery of about 0.06% per week, so around 27 weeks would be needed in order to have a full recovery of chicken consumption for this group.

Finally, notice that those groups that have a significant reduction on chicken consumption react at the first stage of the episode, and not when the risk increases (the second stage, when the virus is detected in France). This could mean that the households adjust their consumption behavior in a "once and for all" fashion, as soon as they consider that the risk exists. The only result that is difficult to understand is the additional decline (even if it is small) on chicken consumption for the mixed group when France recovered its free-of-disease status, which is on the opposite direction to what we were expecting.

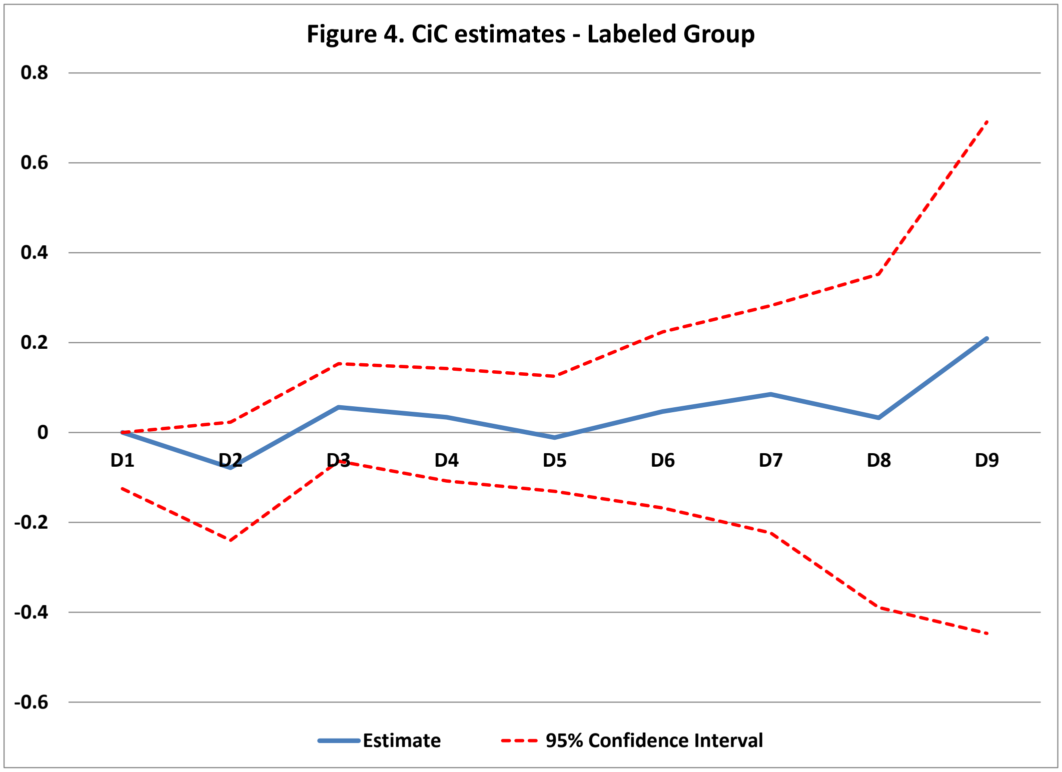
[5] In the tables presenting the results of the interrupted time series analysis we do not present the results for the seasonal dummies. The tables including the dummies are in the annex 2.

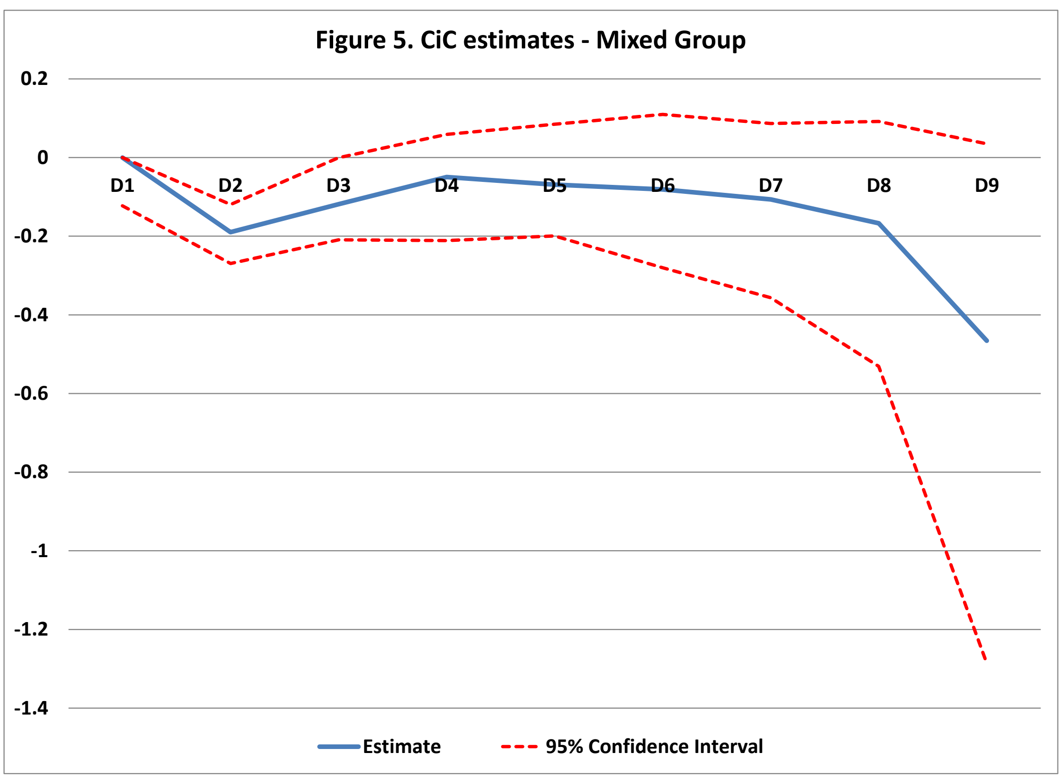
Table 3. Interrupted Time Series Results						
	Labeled Group		Mixed Group		Non-labeled group	
	Estimate	P-value	Estimate	P-value	Estimate	P-value
(Intercept)	0.07181	0.000***	0.04360	0.000***	0.02323	0.000***
t	0.00031	0.011***	0.00027	0.042**	0.00016	0.248
Europe	0.00032	0.646	-0.00024	0.750	-0.00039	0.620
INFO	-0.00052	0.615	0.00080	0.485	0.00109	0.347
France	-0.00033	0.622	-0.00119	0.112	-0.00102	0.182
Free	-0.00001	0.965	0.00026	0.340	0.00011	0.708
Chicken	-0.03784	0.000***	-0.01369	0.004**	-0.00265	0.592
Pasta	-0.04692	0.000***	0.04178	0.000***	0.06762	0.000***
Chicken:t	-0.00001	0.966	-0.00015	0.470	0.00004	0.856
Chicken:Europe	-0.00217	0.016***	-0.00181	0.099*	-0.00085	0.448
Chicken:INFO	0.00283	0.036**	0.00169	0.294	0.00015	0.929
Chicken:France	-0.00010	0.909	0.00116	0.271	0.00120	0.260
Chicken:Free	-0.00046	0.171	-0.00091	0.022**	-0.00061	0.136
Pasta:t	0.00019	0.551	-0.00034	0.050*	-0.00017	0.345
Pasta:Europe	0.00003	0.983	0.00071	0.477	0.00129	0.205
Pasta:INFO	0.00020	0.914	0.00043	0.776	-0.00089	0.560
Pasta:France	-0.00072	0.558	-0.00120	0.223	-0.00092	0.355
Pasta:Free	0.00040	0.429	0.00036	0.338	0.00059	0.119

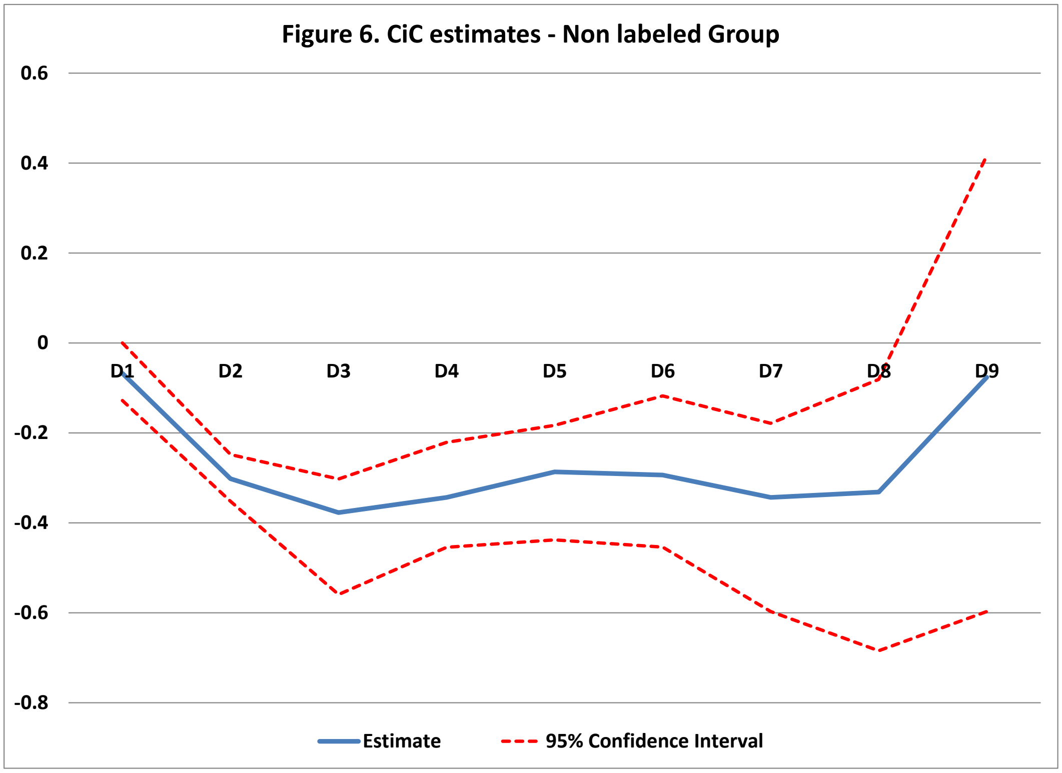
Note: ***, **, and * denote significance at the 2%, 5%, and 10% levels, respectively.

The interrupted time series results can be contrasted with those obtained with the CiC approach to have a bigger picture of what is happening after the avian influenza episode concludes. Figures 4 – 6 present graphically the results for the three groups. On the horizontal axis we have the deciles of the population ranked according to their chicken consumption levels, while in the vertical axis we represent the substitution effect as the relative change on chicken consumption (chicken/beef) in kg.

Results for the labeled group (Figure 4), shows that there is not a significant change on the consumption of chicken relative to beef, so we can say that the avian influenza episode does not make consumers substitute chicken for beef. The story would not be interesting if we do not contrast this result with the previous one. With the time series approach we have seen that labeled households do react to the event declining chicken consumption, but once the FAO-WHO statement is released they react by increasing chicken consumption. So we can conclude that labeled households do react to the event, but once the risk has vanished, they present a full recovery on chicken consumption, so chicken consumption return to the same levels than before the avian influenza took place. The results of both approaches are totally compatible for this group, and notice that without the interrupted time series' results we might end up misinterpreting the CiC results, thinking that there is no reaction of this group to the episode.







The estimates of the mixed group are all negative; although it is significant only for one decile. With the time series approach we have seen that the mixed group react negatively to the avian influenza episode, and for this group the FAO-WHO statement seems to be ineffective, then we should expect most of the estimates negative and significant. Considering that during the event there is a significant reduction on chicken consumption, the results of the CiC approach can be due to an increase on chicken consumption that could take place after the event concludes and therefore it is not reflected in the time series approach, or due to a decrease on beef consumption.

The case of the non-labeled group is quite particular. There is a significant reduction on chicken consumption (relative to beef) which is not reflected on the interrupted time series analysis. We can say that households belonging to this group present a significant substitution effect favoring beef to the detriment of chicken. For this group the results of the different methodologies lead to different conclusions, highlighting the importance of using both approaches to motivate future research.

Finally, it is very interesting to evaluate the effectiveness of the statement released by the FAO-WHO. This strategy of informing the consumers about the actual risk they are facing when consuming chicken that could be contaminated seems to be very ineffective according to our results, since only one group reacts as it is expected.

CONCLUSIONS

In this paper, I estimate the reaction to the avian influenza episode of different types of consumers according to their preference for labeled food in France. Using two different approaches, and a non-equivalent dependent variable approach to control for validity threats, different results are obtained for different types of consumers, i.e. heterogeneity on responses exists.

In the short run, I found that labeled consumers have a significant declining on the consumption of chicken once the avian influenza arrives to Europe but then a significant increase once the FAO-WHO statement is released. So labeled consumers decrease their consumption as soon as the risk is perceived (1^{st} stage of the episode), and readjust their consumption only after the risk vanishes (with the statement), leading to a recovery on the consumption of chicken.

On the other hand, the mixed group reacts significantly to the 1^{st} stage of the episode, by reducing its consumption, but does not present a recovery even after the event finishes. Differently to the labeled and mixed groups, the non-labeled group does not react at all when faces the avian influenza episode.

In the long run, the labeled group does not present a significant difference between the pre-event and post-event consumption of chicken relative to beef, pointing to the inexistence of a persistent substitution effect on the long run due to the avian influenza episode. This is perfectly compatible with the short run story, and gives us a bigger picture of what is happening in reality.

The mixed group ends up with a reduction on the consumption of chicken relative to beef which is compatible with the short run story; however, this reduction is significant only for a small part of the population. Regarding the non-labeled group, there is a significant substitution of chicken for beef comparing the pre- and post-event windows. This is not captured by the time series approach, and further research is needed to clarify it.

We consider that the source of the response's heterogeneity is due to differences on preferences for several aspects involved in consumption decisions (such as animal health, food-safety, etc.) that end up in asymmetric information among the groups. Policy makers should focus in those actions that could eliminate this asymmetry, in order to have well-informed the whole population. Considering the results of this research, better information campaigns could be designed when facing a food safety related event, focusing on the uninformed groups. For example, hard-discount stores account for 2.8%, 8.9%, and 15.5% of chicken's purchases of the labeled, mixed, and non-labeled groups, respectively, while purchases in traditional butcher shops accounts for 10.9%, 6.6%, and 4.5% respectively. So according to our results if the government wants to launch an information campaign, they should focus on those supermarkets where uninformed groups tend to buy, in this case hard-discount stores, instead of butcher shops.

This study is not only relevant for policy makers but also, and specially, for firm managers. The consequences of a food-safety related event can be devastating for some industries. Firms, damaged by the event, must be ready to react as efficiently as possible, and one essential step is to predict the consumer's reaction. The results of this study would suggest to focus in the short run on the labeled-food market by adjusting as fast as possible their inputs demand as well as the production while the risk is present, and once it fades away the efforts of the managers should be oriented to incentive the recovery of the demand, putting special attention to the mixed and non-labeled groups.

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ANNEX 1. Adjustments to eliminate price effects on the data

This adjustment will consider only direct-price effects, and cross-price effects coming from any of the other goods being used in the analysis, i.e. will only consider the effect of changes in prices of chicken, beef, and pasta. Therefore we consider that changes on the price of other goods have negligible or similar effects on the quantities of these three goods.

These adjustments are done by using estimates of direct- and cross-price elasticities of two different studies in France (Allais, 2007; Allen, 2010) which use the same dataset we are using, but over a longer period. For the direct-price elasticity of chicken and beef, and the cross-price elasticities between these two products we use the Allais's estimates, while we consider the Allen's estimates for those elasticities involving pasta (since the study of Allais does not present this information). The estimates of the elasticities being used are:

		Prices		
		Chicken	Beef	Pasta
Quantity	Chicken	-0.935	0.207	-0.016
	Beef	0.093	-1.186	-0.006
	Pasta	-0.020	-0.016	-0.973

Consider $\hat{y}_t$ as the adjusted purchased quantity, the one from which the price effects have been removed. Then, if we call y_t as the original purchased quantity, we have the next definition:

$$y_t = \hat{y}_t * (1 + PE_t)$$

Where PE_t is the effect generated (in percentage change) on quantity y_t due to changes on the prices of the economy. In our case we will limit the price effect to three components: the direct-price effect (*DPE*), and two cross-price effects (*CPE1 & CPE2*). Then $PE_t = DPE_t + CPE1_t + CPE2_t$

Where:

$$DPE_t = \varepsilon_{y,P_y} * \Delta\%P_{yt}$$

$$CPE1_t = \varepsilon_{y,P_{x1}} * \Delta\%P_{x1t}$$

$$CPE2_t = \varepsilon_{y,P_{x2}} * \Delta\%P_{x2t}$$

Where *X1* and *X2* are the two other goods included in the analysis. Therefore we can extract the adjusted data using as inputs the original data, the estimated elasticities, the changes in prices, in the following way:

$$\hat{y}_t = \left(1 + \left[\varepsilon_{y,P_y} * \Delta\%P_{yt}\right] + \left[\varepsilon_{y,P_{x1}} * \Delta\%P_{x1t}\right] + \left[\varepsilon_{y,P_{x2}} * \Delta\%P_{x2t}\right]\right)^{-1} * y_t$$

ANNEX 2. Complete Tables

This is the table of the interrupted time series analysis including the seasonal dummy variables. Notice that there are 12 dummy variables, since there are 13 different seasons in our database (each of it includes a 4 week period, of the total 52 weeks.

Table 3. Interrupted Time Series Results

	Labeled Group		Mixed Group		Non-labeled group	
	Estimate	P-value	Estimate	P-value	Estimate	P-value
(Intercept)	0.07181	0.000***	0.04360	0.000***	0.02323	0.000***
t	0.00031	0.011***	0.00027	0.042**	0.00016	0.248
Europe	0.00032	0.646	-0.00024	0.750	-0.00039	0.620
INFO	-0.00052	0.615	0.00080	0.485	0.00109	0.347
France	-0.00033	0.622	-0.00119	0.112	-0.00102	0.182
Free	-0.00001	0.965	0.00026	0.340	0.00011	0.708
Chicken	-0.03784	0.000***	-0.01369	0.004**	-0.00265	0.592
MES1	0.01335	0.000***	0.01376	0.000***	0.01448	0.000***
MES2	0.00847	0.000***	0.01159	0.000***	0.01107	0.000***
MES3	0.01004	0.000***	0.00809	0.001***	0.00981	0.000***
MES4	0.00902	0.000***	0.00613	0.013***	0.00815	0.001***
MES5	0.00976	0.000***	0.00922	0.000***	0.00944	0.000***
MES6	0.00924	0.000***	0.00526	0.030**	0.00660	0.007***
MES7	0.00215	0.323	-0.00183	0.450	-0.00049	0.842
MES8	0.00333	0.126	-0.00316	0.194	-0.00373	0.131
MES9	0.00904	0.000***	0.00668	0.006***	0.00894	0.000***
MES10	0.00527	0.016***	0.00619	0.012***	0.00809	0.001***
MES11	0.00539	0.009***	0.00550	0.018***	0.00428	0.071*
MES12	0.00419	0.038**	0.00740	0.001***	0.00846	0.000***
Pasta	-0.04692	0.000***	0.04178	0.000***	0.06762	0.000***
Chicken:t	-0.00001	0.966	-0.00015	0.470	0.00004	0.856
Chicken:Europe	-0.00217	0.016***	-0.00181	0.099*	-0.00085	0.448
Chicken:INFO	0.00283	0.036**	0.00169	0.294	0.00015	0.929
Chicken:France	-0.00010	0.909	0.00116	0.271	0.00120	0.260
Chicken:Free	-0.00046	0.171	-0.00091	0.022**	-0.00061	0.136
Pasta:t	0.00019	0.551	-0.00034	0.050*	-0.00017	0.345
Pasta:Europe	0.00003	0.983	0.00071	0.477	0.00129	0.205
Pasta:INFO	0.00020	0.914	0.00043	0.776	-0.00089	0.560
Pasta:France	-0.00072	0.558	-0.00120	0.223	-0.00092	0.355
Pasta:Free	0.00040	0.429	0.00036	0.338	0.00059	0.119