# The Determinants of Survival of Spanish Consumers Fronting the BSE Crisis

**Amr Radwan[1], José M. Gil and Teresa Serra**

*Centre de Recerca en Economia i Desenvolupament Agroalimentaris (CREDA)-UPC-IRTA, Parc Mediterrani de la Tecnologia Edifici ESAB, C/Esteve Terrades, 8 08860 Castelldefels, Barcelona, Spain, e-mails:* amr.radwan@upc.edu , chema.gil@upc.edu, teresa.serra-devesa@upc.edu

## Abstract

The impact of food scares on meat consumption has been traditionally investigated by estimating food demand systems using aggregated time series. Only a few have considered micro data but none of them has tried to quantify consumers' reaction to food scares and the speed of such reactions. In this study we apply duration analysis techniques with the aim of analysing the effect of different explanatory variables on both the risk of reducing beef consumption and the timing of this reduction. Our results suggest that the maximum hazard occurs during the few months after the occurrence of the food crisis and then the reducing consumption hazard tend to diminish. Moreover, economic factors such as prices and income could be considered as the most determinant factors of the survival of the Spanish consumers facing the BSE crisis while other socioeconomic characteristics such as the age, the gender, etc., have a small, if any, effect on the occurrence and the speed of beef consumption reduction indicating a quite homogenous reaction among Spanish consumers to BSE crisis. These results provide interesting insights about how policy makers could orientate food policies in order to recover consumption after a food scare.

*Key words*: Food scare, BSE, duration analysis, reaction timing, Spain.

JEL classification: C41, D1

[1] Corresponding author.

## 1. Introduction

In Spain, while the discovering of BSE in animals outside Spain had a slightly small effect on meat consumption, the detection of confirmed Spanish BSE cases provoked a significant reduction in beef consumption, indicating that food safety concerns may have a potentially impact on meat consumers' preferences in addition to the traditional economic factors of income level and prices. Some studies have tried to quantify, at aggregated level, the effects of food scares on the consumption of different food products (Piggott 2004, Mazzocchi, 2005; and, more recently, Radwan et al., 2008, for Spain). The methodology used is based on the estimation of food demand systems using aggregated time series.

Although it is doubtless that the BSE crisis had resulted in a reduction of beef consumption in Spain (MARM, 2004), it is not less certain that this reduction and the reaction time since the information is available to consumers up to the demand reduction takes place varies substantially among different households depending upon their economic and socio demographic characteristics. A better understanding on how consumers react to food scares is of considerable interest for both policy makers and food industry in order to help them to design the appropriate policies or marketing strategies. Up to our knowledge, there has not been any attempt to quantify consumers' reaction to food scares and the speed of such reactions.

In this context, this paper aims at analysing the effect of both economic and non economic factors on both the occurrence of beef consumption reduction and the timing of this reduction using the duration analysis approach, and more precisely, the Cox Proportional Hazard Model (CPHM) (Cox, 1972). Our data set consists of 462 Spanish households extracted from the Spanish Continuous Household Expenditure Survey (Encuesta Continua de Presupuestos Familiares, ECPF) for years 2000 and 2001 which

provides information on quantities and expenditures on food products as well as socio-demographic and lifestyle variables of participants.

To tackle with this objective, the rest of the paper is organised as follows. Section 2 provides a brief description on the BSE crisis and beef consumption in Spain. The methodological approach applied here is explained in section 3. Our empirical application and the main results are discussed in section 4 and 5 respectively. Finally the paper ends with some concluding remarks.

## 2. BSE crisis and beef consumption in Spain

On November 22, 2000, the first Spanish BSE case was diagnosed and two weeks later the second one. Both cases took place in Galicia (North-West of Spain). Since then, the number of confirmed cases increased notably reaching its peak in 2003 with 167 cases. The total number of confirmed cases in Spain from November 2000 to the end of April 2006 was 768 cases, being the fifth European country more affected by the BSE after U.K., Ireland, France, and Portugal.

Up to now, the incidence in humans has been very limited. More precisely four cases have been confirmed. The first case of Variant Creutzfeldt-Jakob disease (vCJD) was reported in Spain in 2005 in a woman, born in 1978, who developed symptoms in 2004 and died in 2005.The second case was a woman, born in 1957, who developed progressive cognitive deterioration in February and died in December 2007. The third case was a man, born in 1967, who had onset in May 2007 with psychiatric symptoms, and after several months developed progressive cognitive decline with dementia and died in February 2008. The fourth case has been detected in a housewife who was born

on 1944 and died on 2008 with a total period of illness of almost one year. Additionally she is the mother of the third case.

In the case of Spain, beef consumption slightly decreased since 1994, having recovered in 1999 and 2000 (MARM, 2004). However, this recovering process ended with the first case of BSE in Spain in October 2000. Between 2000 and 2001, beef consumption decreased annually by 12%. However, in the very short-run the impact was substantially large (beef consumption decreased from 22 million Kg in October 2000, to 15.8 million Kg in December 2000).

These figures suggest that, in addition to the traditional economic factors (income and prices); food safety concerns may have a potentially significant impact on consumers' demand for meat. Angulo and Gil (2007), in a nation-wide survey, showed that, in Spain, 63% of respondents declared to be more concerned about food safety than five years ago.

The potential impact of food safety on beef consumption has been well reported on the literature (see Piggott and March, 2004; among others, and Radwan et al., 2008, specifically for Spain) but until now there is no information about how this effect differs from a household to another one depending upon its characteristics. In this study we are trying to fill this gap.

## 3. Methods: Duration analysis

Our methodological approach is based on the use of different survival or duration analysis (DA) techniques which were originally applied in biometrics. From the seminal paper of Lancaster (1978), on the duration of unemployment, its use in economic analyses has widespread. In the field of agricultural economics, the implementation of

this approach has focussed on the production side and has been mainly oriented towards the study of adoption of new technologies or the adoption of organic farming (see Burton et al., 2003 or de Souza et al., 1999 among others). However, from the demand side, and especially on the potential impact of food safety concerns on consumption, up to our knowledge, this is the first attempt to apply the duration analysis approach, which constitutes the main contribution of our paper to previous literature.

DA allows controlling both for the occurrence of an event (i.e. whether a consumer reduce its consumption, either temporarily or permanently) and the timing of the event (that is, when the reduction takes place). Therefore, these methods take into account the evolution of the reduction risk and its determinants over time. Moreover, duration analysis techniques are appropriate to account for right censoring (when we only know that the consumer has kept its consumption level at least up to a given period t), and easily handle time-varying covariates. The latter allows overcoming the limitation arising from considering household's characteristics previous to the sample period or at the time of starting the event as the unique determinant of household survival over time. Moreover, the specification of these models may be made flexible enough so as to allow testing the different predictions derived from the theory.

The central concept in survival analysis is the hazard rate. Following Kalbfleisch and Prentice (1980), this is defined as the probability that a consumer reduce its consumption of the affected meat type in a moment t given that it has survived until this period t and conditional on a vector of covariates $X_{it}$ , which may include both time varying and time-constant variables,

$$\lambda\left(t; x_{it}\right) = \lim_{dt \to 0} \frac{pr\left(t \leq T \prec t + dt \setminus T \geq t, x_{it}\right)}{dt}$$

where T is a non-negative random variable (duration)

In order to examine the effect of the explanatory variables on the risk of consumption reduction we have followed a two-step process. First, we have carried out univariate non-parametric tests of equality of hazard (or survival) functions across the r-groups of households obtained according to the values of each explanatory variable. These tests are extensions for censored data of non-parametric rank tests used to compare two or more distributions. Under the null hypothesis, there is no difference in the hazard rate for each of the r groups at any of the failure times. This statistic distributes as a $\chi^2$ with r −1 degrees of freedom.

Secondly, a multivariate analysis is undertaken estimating a semiparametric survival model in order to unravel the effect of each of the explanatory variables on the risk of reduction (alternatively, the probability of survival) controlling simultaneously for the effect of the other variables considered. The estimation is performed using the semi-parametric CPHM (Cox, 1972):

$$\lambda (t ;X_{it} )=\lambda_0 (t) . \exp (X_{it}\beta)$$

where $\lambda_0$ (t) represents the baseline function obtained for values of covariates equal to 0 ($X_{it}$ = 0). In this specification, the effect of the independent variables is a parallel shift of the baseline function, which is estimated for those consumers who survive up to a particular period. The baseline function is left unspecified and the model is estimated maximizing a partial likelihood function with respect to the vector of coefficients β without the need to estimate the baseline function (although it may be recovered non-parametrically).

The CPHM has some desirable properties that make it suitable for our analysis. First, the baseline function is left unspecified. Hence, the potential problem of unobserved heterogeneity that may rise when the baseline function is not properly specified is overcome (Dolton and Van-der-Klauw, 1995). This problem worsens in presence of

time-varying covariates. Second, it is only the ordering of the reduction times what matters for the estimation of the CPHM, and not the actual times by themselves.

## 4. Empirical application

Our data set has been collected from the Spanish Continuous Household Expenditure Survey (Encuesta Continua de Presupuestos Familiares, ECPF), which is conducted by the Spanish National Institute of Statistics (Instituto Nacional de Estadística, INE).The ECPF provides quarterly information on the expenditure and quantity consumed of various classes of food products consumed by a stratified random sample of around 8,000 households. The survey also gathers information on a limited number of household characteristics include the level of education and main activity of the head of the household, household income, household size, age and sex of family members and town size, among others. One eighth of the sample is renewed quarterly and hence an individual can be followed for a maximum of eight quarters (two consecutive years).

However, the participation of each household in the panel was only complete for four quarters while for the remaining four quarters their participation was partial, that is, they only have to record quantities and expenditures for main food groups (i.e. for meat instead of the different types of meat: beef, pork, poultry,...). To overcome this problem, and taking into account that ECPF is divided into 1000 household sections each of them containing 8 households with almost identical characteristics, instead of using single household data we have considered average values for each section giving us a final data set of 462 households[2] from the fourth trimester of 2000 until the fourth trimester

[2] Our final data set consists of a smaller number of households (only 462 out of the potential 1000 sections in which the ECPF is divided). We have applied a two-step filter. Theoretically, each section has to be homogeneous in terms of its household composition. Thus, we have eliminated, first, those households within each section that showed completely different socio-demographic characteristics in

of 2001. Our data set consists of the volume of beef consumption and the specifics characteristic of each group of households.

As DA has been designed for longitudinal data on the occurrence of events, we have to specify what the event we are interested in analysing here is and what is its time origin. Allison (1995) defines an event as "a qualitative change that can be situated in time", that is, a qualitative change indicating the shift from a discrete state to another (i.e. the transition from unemployment to having a job). In this study the chosen event is the reduction of beef consumption by 10% in a specific quarter as the aggregated annual data indicated that the beef consumption decreased by 12% between 2000 and 2001. Moreover, we have tried different percentages of beef consumption reduction but our results were not sensitive for these changes. As the first two BSE confirmed cases took place at the end of November 2000 we have considered the fourth quarter of 2000 as our time origin. It worth also mentioning that our data are right censored because some consumers did not reduce their beef consumption until the end of our analysed period.

## 5. Results

In this section the main results from our study is presented starting with the description of our data set and the evolution of the survival rate along the analysed period (the survival function, which measures the percentage of households in each point of time (quarter) who did not reduce their beef consumption after the occurrence of the BSE crisis). Second, we outline our strategy for selecting the explanatory variables for the

terms of age, education,…). Second, we have eliminated any section in which all households within it had a null beef expenditure in any quarter.

survival model using univariate DA models and the forward stepwise method[3]. Finally, estimated parameters of the CPHM are discussed.

As a first step, Figure 1 shows the survival function of our data set. As can be observed about 35% of the sample react very quickly (taking into account the quarterly nature of data), within the first quarter, reducing their beef consumption as a response to the dissemination by mass media of the first confirmed BSE case in Spain. Another 10% and 5% responded to this food crisis during the second and third quarter respectively and about half of our sample maintain its beef consumption more or less the same as before the announcement. Our results and consistent with previous literature indicating that the maximum hazard of consumption reduction uses to take place during the first few months after the occurrence of the food safety crisis and that afterwards the risk of consumption reduction declined. Patreson and Chen (2005) identified a two months transition period of consumption changes as a response of the BSE crisis in Japan. Also Mazzocchi and Lobb (2005) indicated that, in Italy, beef consumption recovery took place only a few months after the first wave of BSE.

As the ECPF contains a vast number of potential variables be introduced into the duration model to explain beef consumption reduction and the timing of this reduction the two-step procedure outlined in Section 3 has been followed. First, different univariate DA models were estimated and non-parametric tests were carried out to check for the individual significance of each potential variable able to be included in the final model. Additionally, a forward stepwise method has been followed using different combinations of the variables available from our data set. Table 1 presents the summary statistics of the final set of explanatory variables used in this study.

[3] Results of univariate DA models and forward stepwise method are available from the authors upon request.

Then, the CPHM has been estimated with the selected explanatory variables taking into account both that our data are right censored and the tied data problem[4]. Estimated parameters are shown in Table 2. As can be observed, the null hypothesis that all coefficients are equal to zero can be rejected with a 99% confidence level.

Our results suggest that all economic factors seem to have a significant effect on the hazard of beef consumption reduction being the beef price the most important factor. The hazard ratio is around 1.1, indicating that price increases lead to hazard increases of about the same magnitude. If the food policy in Spain had been oriented to beef price reductions, probably the impact of the food scare on beef consumption would have been of lower magnitude. Potentially, lower prices would have compensated the increase in the perceived risk of the BSE as the magnitude of such problem in Spain was smaller than in other EU countries. The other two relevant economic variables (at the 90% level of significance) are the food expenditure and the subjective opinion about the possibility of reaching at the end of the month. In the first case the positive sign of the parameter indicates that as the food expenditure increases, consumers have more alternatives to deviate consumption from beef to other types of meat (like lamb, which is the most expensive meat type in Spain), increasing the hazard of beef consumption reduction. In the second case, the parameter is negative indicating that the likelihood of demand reduction decreases when the household declares not to have budget problems to arrive at the end of the month. Although, it could be a contradictory result with the previous one, it is not the case as we have not found any significant correlation between these two covariates. In other words, people declaring that they not have problems to arrive at the end of the month are not associated with higher food expenditure.

[4] As the duration model was designed originally for biometric data, where the event occurs for each individual in a different point of time, tied data is a problem that appears when applying duration models to economic data where the event occurs for many individuals at the same point of time. In this study we have controlled for this problem to have unbiased results.

Regarding the socio characteristics of households, the gender and the age of the head of the household and the household size have a significant effect on the hazard of beef consumption reduction. The estimated effect is negative in the first case (older people are less likely to reduce beef consumption) and positive in the second (males have a lower hazard of reducing beef consumption). The negative effect of being older is expected and may be explained by the very large incubation period of the human variant of BSE (vCJD), which reduces the perceived risk of the food scare in the case of older people (Mazzocchi, 2006). Finally, risk aversion, education and town size (living in a rural area) does not have any impact on the probability of beef consumption reduction.

These results will be quite helpful in classifying Spanish meat consumers in different segments depending upon their sensitivity to food safety issues which will be useful in designing powerful marketing strategies and public policies.

## 6. Concluding remarks

In this study a Duration Analysis approach, mainly the Cox Proportional Hazard Model (CPHM), has been used to determine main factors affecting both the occurrence and the timing of beef consumption reduction as a response of dissemination by Spanish mass media of confirmed BSE cases in Spain. To achieve this objective, a household panel data set of 462 Spanish households has been used containing information on beef consumption and socioeconomic characteristics of respondents.

Our results suggest that, consistently with previous literature, that the maximum hazard of consumption reduction takes place during the first few months after the occurrence of the food safety crisis. For longer periods, the risk of consumption reduction shrinks. Moreover, economic factors such as prices and food expenditure seems to be the most

significant factors on the likelihood of beef consumption reduction while socio-demographic characteristics of respondents, such as age gender,..., have a smaller effect on the occurrence and the speed of beef consumption reduction, indicating a quite homogenous reaction among Spanish consumer to the BSE crisis. These results could be helpful to both policy makers and marketing strategy designers.

Our analysis can be extended in several ways as authors are aware about some of the limitations of the present study, much of them out of their control. For instance, better data sets would have been more appropriate to tackle with the issue explored in this paper. The main one is, without any doubt the time frequency. This study is based on quarterly data when monthly data would have been preferable. Another potential research line could be to apply DA on other food crisis such as avian influenza and H1N1 (swine) influenza. Also DA models can be applied to analyse the effect of domestic confirmed BSE cases with the aim of comparing consumer reactions in different countries which had implementing alternative food policies. This could give policy makers a clearer idea about the effectiveness of the measures adopted.

**References**


Allison Paul D. 1995.Survival Analysis Using SAS: A Practical Guide. Cary, NC: SAS Institute INC.

Angulo, A.M. and Gil, J.M. (2007). Risk perception and consumer willingness to pay for certified beef in Spain. *Food Quality and Preference*, 18(8): 1106-1117

BURTON, M.; RIGBY, D. and YOUNG, T. (2003). Modelling the adoption of organic horticulture technology in the UK using duration analysis. *The Australian Journal of Agricultural and Resource Economics*, 47(1): 29-54.

Cox, D. R. (1972). Regression models and life tables. *Journal of the Royal Statistical Society*, Series B, 20: 187-220.

De souza, f.; young, t. and burton, m. (1999). Factors influencing the adoption of sustainable agricultural technologies. *Tehnological Forecasting and Social Change*, 60: 97-112.

Kalbfleisch, J. and Prentice, R. (1980). The statistical analysis of failure time data. Wiley, New York.

LANCASTER, T. (1978). Econometric methods for the duration of unemployment. *Econometrica*, 47(4): 939-956.

Mazzocchi, M. (2006). No news is good news: stochastic parameters versus media coverage indices in demand model after food scares. *American Journal of Agricultural Economics*, 88(3): 727-41.

Mazzocchi, M., and Lobb, A. E. (2005). A Latent-variable Approach to Modeling Multiple and Resurgent Meat Scares in Italy. Paper prepared for presentation at the 11th International Congress of the EAAE, Copenhagen, DK, 24-27 August.

Ministerio de Medio Ambiente y Medio Rural y Marino (MARM) (2004). La alimentación en España, 2003. Secretaría General Técnica, Madrid.

Peter Dolton and Wilbert von der Klaauw. (1995). Leaving Teaching in the UK: A Duration Analysis. *The Economic Journal*, 105(429): 431-444.

Peterson, H. H., and Yun-Ju (Kelly) Chen. (2005). The Impact of BSE on Japanese Retail Meat Demand. *Agribusiness*, 21(3): 313-327.

Piggott, N.E. and Marsh, T.L. (2004). Does Food Safery Information Impact U.S. Meat Demand?. *American Journal of Agricultural Economics*, 86(1): 154-74.

RADWAN, A., GIL, J.M., BEN KAABIA, M., SERRA, T. (2008). Modeling the Impact of Food Safety Information on Meat Demand in Spain. 107th European Association of Agricultural Economists Seminar, "Modelling Agricultural and Rural Development Policies," Sevilla, Spain, (available from http://ageconsearch.umn.edu/), January 29 – February 1.

Figure 1 The survival function

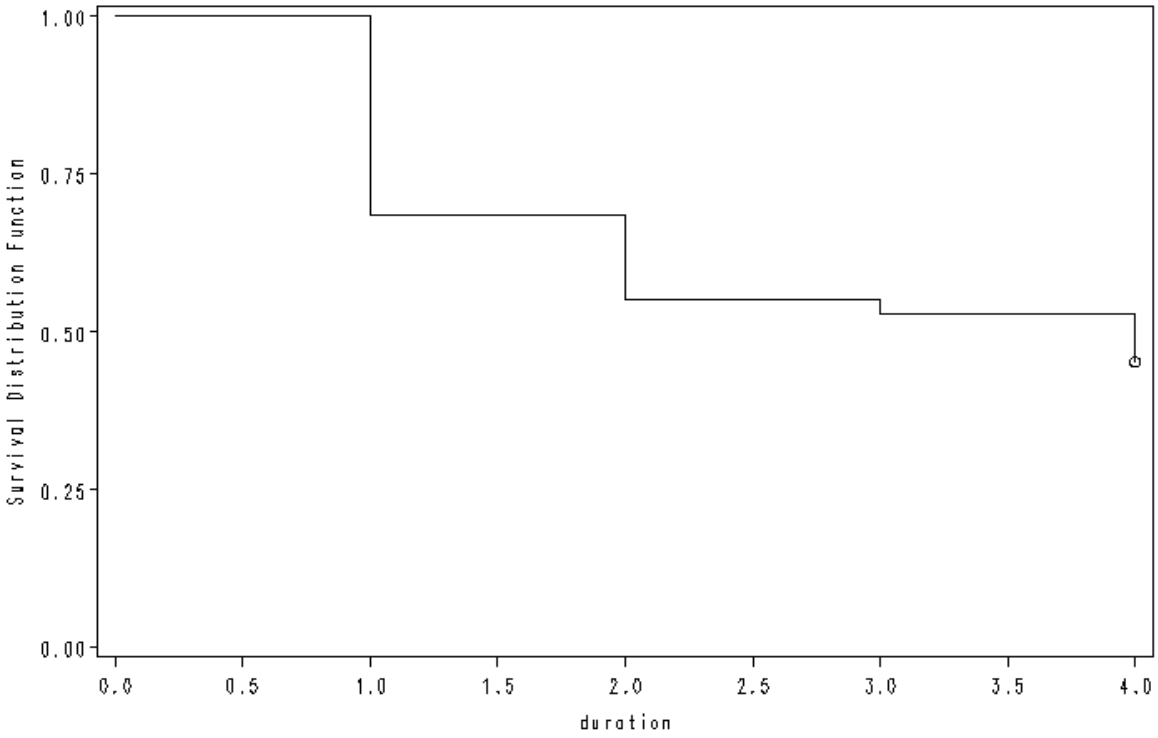

Table1 Descriptive statistics of the Duration analysis explanatory variables

| **Variable** | **Description** | **Mean** | **St. Dev.** |
|---|---|---|---|
| Age | Age of the head of the family in years | 55.32 | 10.82 |
| Male | Dummy variable equals one if the head of the family is male and equals zero otherwise | 0.78 | 0.41 |
| Town size | Dummy variable equals one if town where the household lives is larger than 20000 inhabitants and equals zero otherwise | 0.21 | 0.41 |
| Private health insurance | Dummy variable equals one in the case of having a private health insurance and equals zero otherwise | 0.16 | 0.37 |
| Education | Dummy variable equals one in the case of having at least secondary school education and equals zero otherwise | 0.96 | 0.19 |
| Alone | Dummy variable equals one if the household consists on only one member and equals zero otherwise | 0.08 | 0.27 |
| Family size | The number of family members | 3.34 | 1.13 |
| Food expenditure | food expenditure in euro | 168.92 | 12.09 |
| End of the month | Dummy variable equals one in case the household declares no budget difficulties to reach to the end of the month and equals zero otherwise | 0.84 | 0.37 |
| Price1 | Beef price in euro during the first quarter | 8.57 | 4.14 |
| Price2 | Beef price in euro during the second quarter | 8.53 | 3.54 |
| Price3 | Beef price in euro during the third quarter | 6.88 | 5.79 |
| Price4 | Beef price in euro during the fourth quarter | 8.57 | 3.32 |

Table 2 Estimated parameters of the Cox proportional hazard model

| Variable | Parameter | St. Dev. | P-value | Hazard ratio |
|---|---|---|---|---|
| Private health insurance | -0.054 | 0.221 | 0.809 | 0.948 |
| Age | -0.013* | 0.008 | 0.085 | 0.987 |
| Town size | -0.137 | 0.190 | 0.472 | 0.872 |
| Male | 0.419** | 0.210 | 0.046 | 1.520 |
| Education | 0.258 | 0.439 | 0.557 | 1.294 |
| Alone | 0.113 | 0.317 | 0.722 | 1.119 |
| Family size | -0.156* | 0.091 | 0.087 | 0.856 |
| Food expenditure | 0.012* | 0.007 | 0.073 | 1.012 |
| End of the month | -0.389* | 0.213 | 0.068 | 0.678 |
| Price | 0.101*** | 0.020 | 0.000 | 1.106 |
| Likelihood Ratio: 47.38 (0.000)<br>Wald test: 58.34 (0.000)<br>Lagrange Multiplier Test: 38.26 (0.000) | | | | |

*, ** and *** indicate significant at 90%, 95% and 99% level of significance respectively