FARMER’S OBJECTIVES AS DETERMINANT FACTORS FOR ORGANIC FARMING ADOPTION: THE CASE OF CATALONIA VINEYARD PRODUCTION

SUMMARY

Our paper seeks to assess the decision to adopt organic farming practices. More specifically, we use Duration Analysis (DA) to determine why farmers adopt organic farming and the timing of adoption. We extend previous studies by including farmers’ objectives, risk preferences and agricultural policies as covariates in the DA model. The Analytical Hierarchy Process (AHP) is used as a multi-criteria decision-making methodology to measure farmers’ objectives. The empirical analysis uses farm-level data collected through a questionnaire to a sample of vineyard farms in the Spanish region of Catalonia. Farmers’ objectives are found to influence the conversion decision. Moreover, farmers who are not risk averse are more prone to adopt organic farming. Results also identify the policy changes that have been more relevant in motivating adoption of organic practices.

KEYWORDS: Organic farming adoption, Duration Analysis, Analytical Hierarchy Process, farmers’ objectives.

JEL Classification: Q12, Q18, D80.
1. Introduction and objectives

During the last few decades the European agriculture has been intensifying its production practices. Concerns and awareness about the negative externalities on humans, animals and the environment have been growing. In order to reduce the negative impacts derived from intensive farming, some environmentally friendly production methods such as organic agriculture have been promoted by EU public authorities. Organic agriculture mainly relies on non-polluting inputs and the management of the ecosystem as a whole. Synthetic inputs such as fertilizers or pesticides, veterinary drugs, and genetically modified seeds are replaced, whenever possible, by agronomic, biological and mechanical methods adapted to local conditions and needs (FAO and WHO, 2001).

Organic farming, which has increased substantially in recent years, has received important attention within the Common Agricultural Policy (CAP). The CAP has provided support to organic farming since 1991 by means of a premium subsidy program whereby farmers receive a fixed payment per crop and year (Regulation 2078/91). In 1999, another Regulation (1257/1999) was approved with the aim of improving the efficacy of organic farming. The present support scheme for organic agriculture will be applied until 2013 under the rural development Regulation 1463/2006. Recently, Regulation 889/2008 was passed with the objective of ensuring a fair competition and a proper functioning of the internal market in organic products, and maintaining consumer confidence in products labeled as organic.

There have been several studies that attempt to explain the determinants of adoption of organic production systems. Different approaches have been implemented for this purpose; a) the adoption approach which usually relies upon cross-sectional data which is analyzed by means of probability models to assess the likelihood that conversion occurs (Isin et al., 2007; Genius et al., 2006; De Cock, 2005; Rigby and Young, 2000; Anderson et al., 2005 and Calatrava and González, 2008), b) the diffusion approach which deals with the cumulative adoption rate at the aggregate level using time-series data (Feder and Umali, 1993; Gardebroek and Jongeneel, 2004), c) the impact approach that focuses on the impact of conversion on the physical and financial performance of organic farms, by employing linear mathematical programming and simulation methods (Musshoff and Hirschauer, 2008; Acs et al., 2007 and Kerselaers et al., 2007) and d) the comparison approach that compares organic and conventional farming in various management aspects such as input use, efficiency, productivity, as well as economic results, using basic statistics or profit

---

2 Several studies have compared chemical input use between organic and conventional agriculture. Results are heterogeneous across crops and countries. Oude Lansink et al. (2002) found a 16.66% reduction in chemical input use for the organic crop farms in Finland. A 1.41 % reduction was found for the Cereals, Oilseeds and proteins sector in Spain (Serra and Goodwin, 2009), while a 39.95% reduction for olive farms in Greece was reported by Tzouvelekas et al. (2001).
maximization models, among other methods (Serra et al., 2007; Cisilino and Madau, 2007; Oude Lansink and Jensma, 2003; OECD, 2000; Tzouvelekas et al., 2001 and Klepper et al., 1977).

While the adoption approach fails to allow for the timing of the adoption of organic farming and the impact that time-varying factors may have on it, diffusion studies do not address the issue of why a particular farm adopts earlier than others (Burton et al., 2003). An alternative approach is Duration Analysis (DA) which is capable of analyzing both the decision and diffusion aspects of organic farming adoption. This is accomplished by analyzing cross-sectional and time-variant data jointly in a dynamic framework (McWilliams and Zilberman, 1996). The DA allows determining not only why farmers adopt organic farming, but also the timing of adoption and the factors that influence the observed time patterns. DA allows for changes in the explanatory factors both across farmers and time, thus studying adoption and diffusion together.

Though DA was originally used in biometrics research, it has been applied in a wide range of analyses such as the duration of marriages, spacing births, time to adopt new technologies, product durability, occupational mobility, lifetime of firms, durations of wars, time from initiation to resolution of legal cases (Kiefer, 1988 and Lancaster, 1992), etc. The first application in economics was carried out by Lancaster (1978) in the field of labor economics, to analyze the duration of unemployment and the rates of entry and exit.

In agriculture, DA has been recently applied in different adoption studies such as the adoption of conservation tillage (Fuglie and Kascak, 2001; and D’Emden et al., 2006), animal and plant breeding (Abdulai and Huffman, 2005; and Matuschke and Qaim, 2008), input innovation (Dadi et al., 2004), and sustainable technology adoption (De Souza et al., 1999). Only a few analyses have used the DA to assess the adoption of organic farming practices: the published paper by Burton et al. (2003) and the unpublished manuscript by Hattam and Holloway (2007).

Our paper aims to analyze the adoption of organic practices in the vineyard sector in the Spanish region of Catalonia by making use of DA. We seek to assess the influence of farmer characteristics, attitudes and opinions, farm structure, farm management results and other exogenous factors on adoption. In this context, our work contributes to previous literature by extending DA analysis to a consideration of farmer objectives as relevant factors in explaining the decision to convert. Our analysis also makes a thorough exploration of the role of farmers’ attitudes and opinions in organic farming adoption and introduces farmers’ risk preferences into the model. Additionally, we seek to analyze the impact of agricultural policy instruments on the duration of adoption. Another contribution of this article is the consideration of the random censoring feature that characterizes all organic adoption data and which has not been addressed before. Finally, this...
paper contributes to the scarce literature on the duration of organic adoption. In this context, there are no currently published studies on this topic in Spain.

The determinants of organic farming adoption can be classified into two broad groups: non-economic and economic factors. The former group includes farmer’s attitudes, opinions and objectives as relevant elements. In the later group we mainly find market prices, profit making and public support. Most studies (Burton et al., 1999; Rigby et al., 2001; or Padel, 2001) that have analyzed the adoption of organic farming have found both types of factors to be relevant. In this line, attitudes and preferences are important determinants of adoption decisions (De Cock, 2005; De Souza et al., 1999; Burton et al., 1999 and Ajzen and Fishebin, 1977). While differences in attitudes and opinions between organic and conventional farmers can contribute to explain conversion, they can usually interact and influence each other in a complex form (De Cock, 2005). To capture and simplify this complexity, we use the Principal Components Analysis (PCA). The resulting factors from PCA are used as explanatory variables of organic adoption. In addition, we use the Analytical Hierarchy Process (AHP) as a multi-criteria decision-making methodology to measure farmers’ objectives and we include these measures as covariates in the DA.

The remainder of this paper is organized as follows. Section 2 provides details on the organic sector in Spain and Catalonia. The third section explores studies on adoption in agriculture. In Sections 4 and 5, we present the conceptual framework and the empirical application, respectively. Results are discussed in section 6. Finally, some conclusions are outlined.

2. The organic agriculture sector

Organic agriculture has experienced rapid growth worldwide with currently 32.2 million ha being managed organically by more than 1.2 million producers (Willer and Klicher, 2009). Oceania occupies the first position with 12.1 million ha, followed by Europe (7.8 million ha), Latin America (6.4 million ha), Asia (2.9 million ha), North America (2.2 million ha) and Africa (0.9 million ha). In this context, Australia (12 million ha), Argentina (2.8 million ha) and Brazil (1.76 million ha) are the countries with largest organically managed land area.

In the EU the organic area represents 4% of the total Utilized Agricultural Area (UAA) which is managed by more than 180,000 organic farms (Willer and Klicher, 2009). Spain holds the largest organic area within the EU (1,317,752 ha and 23,473 organic farms (MARM, 2008)) followed by Italy (1,1507,253 ha managed by 50,276 organic farms (SINAB, 2008)) and Germany (907,786 ha and 19,813 organic farms (BMELV, 2008)). If we rank European countries according to the relative
importance of the organic area within the total UAA, Spain occupies the 14th place with 3.7%. In
the first positions we find Liechtenstein (29%), Austria (13%) and Switzerland (11%).
In Spain, the average size of an organic farm is about 51.5 ha, which is above the European
average size (37.7 ha). Within the last 15 years the Spanish organic sector, as in most European
countries, has experienced spectacular growth. While in 1991 there were only 369 organic
operators, there are currently 23,473 organic operators, of which 74.5% cultivate crops and 16.2%
are livestock growers, according to the most recent available statistics (MARM, 2008). The
remaining percentage accounts for processors and importers. The most important organic crops in
Spain are cereals and pulses (9.57%), olives (7.68%), nuts (5.31%) and vineyards (2.34%).

Spanish organic farming was at first regulated by a generic "organic produce" brand introduced in
1989. Initially, the national Board for Organic Agriculture was in charge of controlling production
throughout the country. In 1993, the control was handed over to the regional authorities. In 2000, a
logotype was created to be voluntarily used in the labeling of organic products. Recently, the
National Organic Action Plan (2007 - 2010) has been approved in order to apply a set of specific
actions on organic farming, organic produce processing, marketing, distribution and consumption,
and also on the education and research areas (MARM, 2008).

Catalonia is one of the most important regions within Spain in organic farming. It occupies the fifth
place in the distribution of the Spanish organic area (4.73%), after Andalucía (59.50%), Castilla-La
Mancha (9.08%), Aragón (5.35%) and Extremadura (6.51%). The Catalan sector also occupies the
fourth position within the Spanish vineyard organic sector, representing 7.26% of the total area
(MARM, 2008). Over the last decade, the Catalan organic vineyard sector has experienced the
fastest growth within the Catalan organic sector, with an increase on the order of 981.56% from
1995 to 2008. Vineyard growth rates are followed by those experienced by cereals and pulses
(550.39%), vegetables (342.78%), olive groves (213.08%) and nuts (49.11%).

Catalonia has 147 registered organic vineyard farmers that represent the targeted organic
population in our study. The decision to focus on this activity is based on various factors: a) the
decision to go organic in this sector is not very likely to be subsidy-driven. It is more likely to be
motivated by market conditions due to the high added value of its final product, b) the rapid growth
of the Catalan organic vineyard sector compared to other sectors since 1995, and c) its relative
weight within the total organic sector both in Spain and Catalonia.
3. Determinants of adoption in agriculture

Several studies (Knowler and Bradshaw, 2007; Rigby et al., 2001; Padel, 2001 and Lampkin and Padel, 1994) have reviewed and summarized the factors that influence adoption decisions in agriculture. Rigby et al. (2001), Padel (2001), or Knowler and Bradshaw (2007) have focused their revision on organic farming. We update these latter revisions by listing new applications and studies, their applied methodology and sample size (Table 1). According to the studies reviewed, the most relevant factors that can influence the decision to convert from conventional to organic farming include:

1. *Farmer Characteristics*: gender, education, age, experience, etc.
2. *Farm Structure*: location, farm size, soil type, machinery, etc.
3. *Farm Management*: input use, crop diversification, crop rotation, etc.
4. *Exogenous factors*: output and input prices, market size, subsidies, information access, transition costs, policy reforms, etc.
5. *Attitudes and opinions*: farmer beliefs about the environment, acceptance within the rural community, life style, health and environmental preoccupations, etc.

Table 1 here

In Table 2 we present a summary of the variables that usually explain organic farming adoption and the impact they generally have on the decision to adopt. Young women with high levels of education are more likely to adopt. Conversely, older farmers with relevant social networks are less prone to convert. Adoption is also higher among family farms, farms with steep slope land, high soil quality and with easy access to water. Other farmer characteristics can also influence positively the decision to convert. Farmers who are concerned with environmental problems, food safety and soil degradation are more prone to adopt. Further, these farmers tend to use internet technology when managing the farm. With regards to the economic variables, we state the importance of policy support and price premiums as determinant factors of conversion.

Table 2 here

4. Methods

The five main groups of variables explaining adoption in agriculture and identified by the literature review in the previous section are used in our analysis. As noted, these groups are *Farmer
characteristics \((F_i)\), Farm structure \((S_i)\), Farm management and results \((M_i)\), Exogenous factors \((E_i)\), and Attitudes and opinions \((A_i)\). We contribute to previous literature by also including another set of variables representing Farmers’ objectives \((O_i)\). Farmers’ attitudes and opinions are summarized into factors by using the Principal Components Analysis (PCA) and, farmers’ objectives are identified by a focus group analysis and measured by applying Analytical Hierarchy Process (AHP) techniques. Below we offer details on AHP and DA methodologies. Figure 1 represents a diagram of the methodology implemented.

\[\text{Figure 1 here}\]

**4.1. The Analytical Hierarchy Process (AHP)**

As mentioned before, we hypothesize that farmers’ objectives can play an important role in determining the adoption of organic practices (De Cock, 2005). However, to collect information about the relative importance of each objective for each farmer is usually a complicated task. To overcome this difficulty, in a first step the focus group technique is applied to identify and develop a rich understanding of the critical issues related to farmers’ objectives. In contrast to individuals answering formal questions, this qualitative analysis, based on a group discussion formed by 4 to 15 participants, allows for testing concepts and brainstorming (Edmunds, 1999). In a second step, we use the AHP methodology that measures and determines the relative importance of farmers’ objectives identified previously, allowing us to use the results as a covariate in the DA model. The AHP is a technique (Saaty, 1977, 1980) to support multi-criteria decision-making in discrete environments. AHP allows us to weigh each farmer’s objectives and use them to explain production decisions. In order to implement the AHP, one needs to carry out a survey where individuals are asked to value different objectives that follow a hierarchical structure (Figure 2). We distinguish between economic, environmental and socio-cultural objectives. Each objective in the tree is divided into three different sub-objectives to be also valued.

\[\text{Figure 2 here}\]

The relative importance or weights \((w_i)\) of objectives are obtained from paired comparisons. In order to make these comparisons and determine the intensity of preferences for each option, Saaty (1980) proposed and justified the use of a 1 to 9 scale. The relative importance of each objective is obtained by comparing this objective with all other objectives. From the answers provided, a matrix with the following structure is generated for each individual \((k)\) (Saaty matrix):
where \( a_{ijk} \) represents the value obtained from the comparison between objective \( i \) and objective \( j \) for each individual. This square matrix has two fundamental properties: (a) all elements of its main diagonal take a value of one (\( a_{iik} = 1 \) \( \forall \) \( i \)), and (b) all other elements maintain that paired comparisons are reciprocal (if \( a_{ijk} = x \) then \( a_{jik} = 1/x \)). If perfect consistency in preferences holds for each decision-maker the values given for paired comparisons will represent the weights of each objective; \( a_{ijk} \cdot w_{ik} / w_{jk} \) for all \( i \) and \( j \). As a result, it should also hold that for any \( i, j \) and \( h \) where \( h \) represents any objective (principal or secondary) within the decision tree, \( a_{ihk} \cdot a_{pj} = (w_{ik} / w_{jk}) \cdot (w_{ik} / w_{jk}) = w_{ik} / w_{jk} = a_{ijk} \). Therefore, the Saaty matrix can also be expressed as follows:

\[
A_k = \begin{bmatrix}
  a_{11k} & a_{12k} & \ldots & a_{1nk} \\
  a_{21k} & a_{22k} & \ldots & a_{2nk} \\
  \vdots & \vdots & \ddots & \vdots \\
  a_{nk1} & a_{n2k} & \ldots & a_{nnk}
\end{bmatrix}
\]  

(1)

Thus, if the decision-makers’ property of perfect consistency holds, \( n \) weights \( (w_{ik}) \) for each objective can be easily determined from the \( n(n-1)/2 \) values for \( a_{ijk} \). Unfortunately, perfect consistency is seldom present in reality, where personal subjectivity plays an important role in doing the paired comparison. For Saaty, matrices \((A_k=a_{ijk})\) in which some degree of inconsistency is present, alternative approaches have been proposed to estimate the weight vector that best resembles the decision-makers’ real weight vector. Saaty (1980 and 2003) proposed two options as the best estimate of real weights: the geometric mean and the main eigenvector. Other authors have proposed alternatives based on regression analysis (Laininen and Hämäläinen, 2003) or goal programming (Bryson, 1995). No consensus has been reached regarding what alternative outperforms the others (Fichtner, 1986). As all criteria meet the requirements to estimate the above-mentioned weights, we choose the geometric mean (Aguarón and Moreno, 2000; Kallas et
al., 2007). Using this approach, weights assigned by farmers to each objective are obtained using the following expression:

\[ w_{ik} = \sqrt{\prod_{j=1}^{n} a_{ijk}} \quad \forall \ i, k \]  \hspace{1cm} (3)

Variables \( w_{ik} \) are used as covariates in the DA analysis. AHP was originally conceived for individual decision-making, but it was rapidly extended as a valid technique for the analysis of group decisions (Easley et al., 2000). To compare objective weights between organic and conventional farmers, group preferences must be considered. Thus, we need to aggregate the corresponding farmer’s weights \( (w_{ik}) \) across farmers to obtain a synthesis of weights for each objective \( (w_i) \). The aggregation process should be carried out following Forman and Peniwati (1998), who consider that the most suitable method for aggregating individual weights \( (w_{ik}) \) in a social collective decision-making context is that of the geometric mean:

\[ w_i = \sqrt[m]{\prod_{k=1}^{m} w_{ik}} \quad \forall \ i \]  \hspace{1cm} (4)

where \( w_i \) is used to summarize the results of the AHP analysis.

4.2. The Duration Analysis (DA)

Duration analysis (DA) or duration modeling, as known in the economics field, models the time length of a spell or the duration of an episode or “event”. The spell starts at the time of entry into a specific state and ends at a point when a new state is entered. As mentioned before, we apply DA to identify the determinants of adoption for organic practices, as well as the probability of a farm adopting organic practices at time \( t \), given it has not adopted by that time. We assume that the end of an event or the entering into a new state happens just once for each subject\(^3\).

The conceptual foundations of DA rely on probability theory. Instead of focusing on the time length of a spell, one can consider the probability of its end or the probability of transition to a new state. To determine this probability, DA analysis uses the hazard function instead of the familiar probability distribution function.

\(^3\) When events happen more than once, a multilevel modeling for recurring events or repeated events should be applied (for more information see Box-Steffensmeier and Zorn, 2002 and Steele, 2008 among others).
Consider \( T \) as the random variable that measures the length of a spell. Also consider \( t \) as a realization of \( T \). Thus, the observed durations of each subject consist of a series of data \((t_1, t_2, \ldots, t_n)\). Let \( f(t) \) be a continuous probability distribution function (PDF) of the previously defined random variable \( T \). The probability distribution of the duration variable can be specified by the cumulative density function (CDF):

\[
F(t) = \int_0^t f(s) \, ds = \Pr(T \leq t)
\]  
(5)

which indicates the probability of the random variable \( T \) being smaller than a certain value \( t \). However, in duration analysis we are more interested in the probability that the spell has a length of at least \( t \). This probability is given by the survivor function also known as the complementary cumulative distribution function (CCDF).

\[
S(t) = 1 - F(t) = \int_t^\infty f(s) \, ds = \Pr(T > t)
\]  
(6)

The probability of a duration end or a regime change in the next short interval of time \( \Delta t \), given that the spell has lasted up to \( t \) is:

\[
\Pr(t \leq T < t + \Delta t | T \geq t)
\]  
(7)

On the basis of this probability we define the hazard function or hazard rate that specifies the rate at which a spell is completed at time \( T = t \), given it survives until time \( t \). In other words, in our analysis, the hazard function represents the probability that a farmer adopts organic practices at time \( t \), given he has not adopted before \( t \):

\[
h(t) = \lim_{\Delta t \to 0} \frac{\Pr(t \leq T < t + \Delta t | T \geq t)}{\Delta t} = \lim_{\Delta t \to 0} \frac{F(t + \Delta t) - F(t)}{\Delta t S(t)} = \frac{f(t)}{S(t)}
\]  
(8)

Functions \( f(t) \), \( F(t) \), \( S(t) \), and \( h(t) \) are mathematically related as follows:
\[ h(t) = \frac{f(t)}{S(t)} = \frac{(dF/dt)}{S(t)} = \frac{[d(1-S)/dt]}{S(t)} = \frac{(-dS/dt)}{S(t)} = -d \ln S(t)/dt \]  

(9)

Besides the length of a spell, a set of explanatory variables of economic and non-economic nature may be expected to influence and alter the distribution of the duration. With the inclusion of additional explanatory variables in the DA, the hazard function needs to be redefined and reformulated as being conditional on these variables (Lancaster, 1992):

\[ h(t, x, \theta, \beta) = \lim_{\Delta \to 0} \frac{\Pr(T \leq t + \Delta \mid T \geq t)}{\Delta} \]

(10)

where \( \beta \) is a vector of unknown parameters of \( x \), the vector of explanatory variables, which may include time invariant and time-varying variables, and \( \theta \) is a vector of parameters that characterize the distribution function of the hazard rate.

After the inclusion of the explanatory variables, the hazard function \( h(t, x, \theta, \beta) \) can be split into two components. The first component is the part of hazard that depends on subject characteristics \( g(x, \beta) \). The second one is the baseline hazard function \( h_0(t) \) which is equal to the hazard when all covariates are zero and therefore it does not depend on individual characteristics. This component captures the way the hazard rate varies along duration.

To estimate the duration model we use the semiparametric Cox proportional hazards model (Cox, 1972). The Cox's semiparametric model has been widely used in the analysis of survival data to explain the effect of explanatory variables on hazard rates. Though the semiparametric model could potentially be less efficient than the parametric models in its use of the information provided by the data (D'Emden et al., 2006), the loss of efficiency is likely to be quite small (Efron, 1977 and Lawless, 1982). Moreover, when using this model we can gain robustness in return (Allison, 1995), because the estimates have good properties regardless of the actual shape of the baseline hazard function. In this context, the advantage of a semiparametric model is that no assumptions need to be made about the shape of the hazard function.

Under the Cox proportional hazards model, the duration of each member of a population is assumed to follow its own hazard function \( h_i(t) \) which can be expressed as:
\[ h_i(t) = h(t; \mathbf{x}_i) = h_0(t) \exp(\mathbf{x}_i \mathbf{\beta}) = h_0(t) \exp(\beta_i x_{i_1} + \cdots + \beta_k x_{i_k}) , \]  

(11)

thus,

\[ \log h_i(t) = \alpha(t) + \beta_1 x_{i_1} + \cdots + \beta_k x_{i_k} \]

(12)

where \( h_0(t) \) is an arbitrary and unspecified baseline hazard function, except that it can’t be negative and \( \alpha(t) = \log h_0(t) \). The \( \mathbf{\beta} \) coefficients can be interpreted as the constant proportional effect of \( \mathbf{x} \) on the conditional probability of completing a spell. The property that individuals in the sample display proportional hazard functions is met because the ratio \( \frac{h_i(t)}{h_j(t)} = \exp\{\beta_1 (x_{i_1} - x_{j_1}) + \cdots + \beta_k (x_{i_k} - x_{j_k})\} \) of two subjects \( i \) and \( j \) is constant over time \( t \), since \( h_0(t) \) cancels out.

The estimation procedure is based on the partial likelihood function introduced by Cox (1972, 1975), which eliminates the unknown baseline hazard \( h_0(t) \) and thus discards the portion of the likelihood function that contains information on the dependence of the hazard on time. Additionally, this partial function does account for censored duration. Considering the duration for each subject \( i \), \( t_i \), \( i = 1 \ldots n \), the partial log-likelihood function can be expressed as:

\[ PL = \prod_{i=1}^{n} \left[ \frac{e^{\mathbf{\beta} \mathbf{x}_i}}{\sum_{j=1}^{n} Y_j e^{\mathbf{\beta} \mathbf{x}_j}} \right]^{\delta_i} \]

(13)

where, \( \delta_i \) is an indicator variable with a value of 1 if \( t_i \) is uncensored or a value of 0 if \( t_i \) is censored. \( Y_j \) has a value of 1 if \( t_j \geq t_i \) and \( Y_j = 0 \) if \( t_j < t_i \). The optimization problem to maximize the partial likelihood function can be expressed as:

\[ \log PL = \max \sum_{i=1}^{n} \delta_i \left[ \mathbf{\beta} \mathbf{x}_i - \log \left( \sum_{j=1}^{n} Y_j e^{\mathbf{\beta} \mathbf{x}_j} \right) \right] \]

(14)
5. Empirical application

Data used in this analysis were obtained from face-to-face questionnaires with farmers carried out during March-June 2008 in the major organic grape-growing areas in Catalonia. The choice of these areas was based on the list of certified organic farmers obtained from the official certification organism in Catalonia (CCPAE). Following previous research, neighboring conventional farms were also chosen so that the two subsamples would have an analogous composition (Tzouvelekas et al., 2001). Specifically, for each organic farm, we selected at least three conventional farms located in the same area. The final sample consists of 26 organic and 94 conventional farms.

The survey collects extensive information on farmer’s characteristics, attitudes and opinions, farm physical and economic characteristics and on the determinants of adoption of organic practices. Information collected on farmer and household characteristics \(F_i\) includes age, gender, education, whether other household members have a university degree, number of family members, or nearness of family and friends to farmer residence. Information gathered on farm characteristics \(S_i\) consists of farm size, ownership of the farm, distance between farm and farmer residence, UAA, whether the farm is located in a disfavoured area according to the CAP, farm altitude, number of plots in the farm, water availability, soil quality, or number of organic farms within a 10 km radius. Variables reflecting farm management and results \(M_i\) are: preferred sources of information on agricultural practices, number of soil analyses per year, proportion of rented land, number of cultivated grape varieties, proportion of irrigated land, percentage of total family income coming from agriculture, internet and e-mail use, accounting software use, percentage of sales to conventional wholesalers and/or processors, family labour, number of generations working in the farm, paid Annual Working Units (AWU), income per hectare, or total cost per hectare. Exogenous factors \(E_i\) include, among others, availability of information sources, difficulties in obtaining information, problems in getting loans, output prices, or public subsidies.

Information on attitudes and opinions \(A_i\) was collected by presenting farmers with a series of different statements about organic practices, environment, and other general questions. On a Likert scale from 0 to 10, farmers were asked how much they agreed with different statements on risk attitudes, the use of dangerous and chemical inputs, regulatory issues, the perception of economic agents toward organic farming, farmers’ incentives to convert and farmer’s opinions toward organic farming. Since extensive information on this issue was gathered, and as noted
above, the available information was reduced to lower dimensions using PCA. The resulting factors were used in a subsequent step as independent variables in the DA.

Information on farmers’ objectives\(^4\) \((O_i)\) was collected by asking farmers to make a paired comparison of different objectives using a 1 to 9 scale. As noted, three primary objectives were considered in the comparison: economic, environmental and socio-cultural. Within each primary objective, farmers were also asked to make pair-wise comparisons among three secondary objectives. Secondary economic objectives were: “maximize vineyard sales”, “maximize total farm income from agricultural and non-agricultural activities” and “maximize profits”. The environmental secondary objectives included: “promoting environmentally friendly farming practices”, “maintain soil fertility” and “rational use of water”. The secondary socio-cultural objectives were: “generate employment in the farmer area”, “keep the existing socio-cultural values” and “prevent the depopulation of rural areas”. From the results, we identified the relative weights of each objective that were then used as covariates in the DA.

Apart from the information collected in the survey, other time-variant variables were also considered in the DA, in order to capture systematic changes in the economic conditions and farmers’ characteristics that could affect their decision to adopt (Burton et al., 2003 and Allison, 1995). We used several dummy variables representing policy changes which include a dummy taking the value of one on and after the year 1991, when regulation 2078/91 was passed, and zero otherwise. Another dummy variable representing the period from the creation of the official certification organism in Catalonia (1995 and onwards), was also defined. In addition, a dummy variable was used to distinguish between the post and pre Regulation 1257/1999 period. Finally, a dummy variable was considered to capture the impact of the creation of the logotype “organic agriculture- control system” in 2001. Furthermore, several calendar year time trend covariates were considered (Burton et al., 2003). The first one takes a value of -31 in 1961 (first year “at risk”, i.e. first entry date in our sample), with an increment of one until 1991. The second one takes a value of -35 in 1961, with an increment of one until 1995. The last trend takes a value of -39 in 1961, with increment of one until 1999.

The dependent variable used in the DA is the time farmers waited before adopting organic farming. As Kiefer (1988) mentions, DA requires a precise beginning time to compute the duration. In our

\(^4\) Primary and secondary objectives were defined through two different focus groups. The first was integrated by university faculty specialized in the field of agricultural economics, and the second was composed by policy makers and leaders of agricultural associations.
case, it was set as the date when the farmer started to manage farm\(^5\). It is also necessary to define a time scale which is "years" in our case, as well as the event ending duration (the year when the farmer adopts organic practices). Because not all farmers had adopted organic farming by the time of carrying out the survey, a right censoring characterizes our data. Further, as mentioned before, the data suffer from the random censoring characteristic. This characteristic is due to different entry times (the year when the farmer started managing the farm), that vary randomly across farmers. As Allison (1995) recommends, an easy solution to random censoring is to include the entry time as a covariate in the regression.

6. Results

As a result of the PCA application to measure farmers' attitudes and opinions, several factors were obtained. The first PCA was applied to the variables measuring the perception by the farmer of the attitudes of society toward organic farming. The resulting relevant factors are: “perception by commercial agents” \((a_1)\) and “perception by social agents” \((a_2)\) (see Table 3). The second PCA was applied to farmers’ incentives to convert to organic farming. The derived factors are: “National and international perspectives” \((a_3)\), “economic motivations” \((a_4)\) and “personal motivations” \((a_5)\). The third PCA was applied to farmers' own opinions toward organic farming with “quality and image” \((a_6)\) and “future viability” \((a_7)\) as relevant factors.

\textit{Table 3 here}

As noted above, the AHP allows obtaining the weights assigned by each individual to the primary and secondary objectives using the geometric mean criteria. Results from the aggregation of the weights for the three primary objectives \((w_{o_1}, w_{o_2} \text{ and } w_{o_3})\) across farmers are shown in Table 4.

\textit{Table 4 here}

These results suggest that for conventional farmers the economic objective is the most important with an aggregate weight \((w_{o_1})\) of 62.3%. Environmental \((w_{o_2})\) and socio-cultural \((w_{o_3})\) objectives occupy the second and third positions with aggregate weights of 24.1% and 13.6%, respectively. This hierarchy is also applicable to the organic group, but environmental and socio-cultural objectives have a higher relative relevance while that for the economic objective diminishes.

\(^5\) This decision was taken because organic farming has always been “available” to farms (Burton \textit{et al.}, 2003).
Results from weighting the secondary objectives are summarized in Figure 3. As can be seen, there are differences in relative weights between conventional and organic farmers. It is worth mentioning that while organic farmers are more interested in promoting practices that do not harm the environment, conventional farmers give more importance to water and soil quality. From these results we derive the proportions of the relative weights within the primary and secondary objective groups for each individual (see Table 5 for summary statistics). As explained, these proportions are used in a posterior step as independent variables in the DA.

**Figure 3 here**

**Table 5 here**

Different DA models were estimated using different combinations of the variables available from the survey. We followed the Akaike Information criterion (AIC) and the Schwarz Information Criterion (SIC) to compare between the competing duration models and determine the list of variables to be included in the final model. Summary statistics of these explanatory variables for both types of farmers are shown in Appendix 1. The resulting model is presented in Table 6. At a 95% confidence level, we can reject the null hypothesis that all coefficients are jointly equal to zero.

**Table 6 here**

The presence of a local authority serving as a source of information is found to increase the hazard function, which involves a reduction in the time needed to convert. This result is in accordance with the findings of Rigby *et al.* (2001), Padel, (2001) and Parra and Calatrava (2005) who conclude that the availability of information sources is an important factor in explaining conversion. Results also suggest that farmers that take risky management decisions are more prone to adopt organic farming\(^6\), confirming the findings by De Cock (2005) who states that conventional farmers usually

\(^6\) In order to include farmers’ subjective risk behavior as an explanatory variable, we used a likert scale from 0 to 10. As mentioned by Pennings and Garcia (2001), within the multi-item scale approach to measure risk attitudes the Likert procedure has performed well with regards to reliability and validity and it is the most commonly used. The following question in the survey was formulated to build the scale: “From 0 to 10, indicate the level of risk you assume in your farm production and management decisions (where 0 = No risk at all and 10 = high levels of risk). To include this variable in our model we categorized this scale into three groups. 1) Values from 0 to 3, representing farmers that take low or no risks at all; i.e. that they are risk averse. 2) Values from 4 to 6, representing farmers that undertake moderate risk levels and 3) values from 7 to 10, representing farmers that take high risks; i.e. risk-loving farmers. A dummy variable representing the risk-loving farmers (the third category) was included in the duration analysis.
pay more attention to risk than organic farmers. Compatible with these results, Serra et al. (2008) and Gardebroek (2006) find that organic farmers are less risk averse than their conventional counterparts. Our results also show that difficulties in getting loans increase adoption. This result could be explained by the fact that adopters are mainly small family farms that usually display more conservative leverage levels and have more problems in getting loans than their conventional counterparts. The finding that credit restrictions reduce adoption is in contrast with the results obtained by Padel (2001) and Rigby et al. (2001) who find that refusal of loans and insurance is one of the most important institutional barriers to adoption.

As expected, we find that the location of farms in a disfavored area, which usually involves the presence of some management difficulties, motivates adoption. This is in accord with the results by Padel and Lampkin (1994), Padel (2001) and Rigby and Young (2000). Farmers who have a second economic activity, apart from agriculture, are more likely to convert. Also, farmers whose total farm income is only coming from viticulture are less prone to convert. These results are in line with those obtained by Peters (1994), Padel (2001) and Hanson et al. (2004) who found that diversification of production may play an important role in increasing the probability of conversion. These results are also compatible with the fact that organic farms usually diversify their activities, which reduces the risk derived from possible yield losses. Farmers whose decision to adopt is mainly based on commercial reasons are found to have a lower hazard.

Results suggest also that farmers with positive attitudes and opinions toward organic farming have a shorter duration. Those who believe in a positive perception of social agents towards organic agriculture, agree that dangerous chemical inputs should be prohibited and consider that organic products are of high quality, have a higher hazard to convert. Rigby et al. (2001) and Parra and Calatrava (2005) also found that positive attitudes positively influence the decision to adopt.

Other obtained results are also as expected. Compatible with Padel (2001), Rigby and Young (2000) and Anderson et al. (2005), older farmers are found to be less likely to adopt. Farmers who have recently undertaken the management of the farm have a higher hazard to convert, in accordance with other studies (Lockeretz, 1995; Burton et al., 1999; Padel, 2001, and Hattam and Holloway, 2004), organic farms tend to be smaller than conventional farms. Thus, large farms have a lower hazard and thus a higher duration-time. It is also worth mentioning that an increase in white wine prices increases the hazard which, consistently with Rigby and Young (2000), Burton et al. (2003) and De Cock (2005), suggests the relevance of economic determinants when explaining adoption. Furthermore, white wine represents 70% of the total wine produced in Catalonia (mainly sold as sparkling wine) and is one of the most popular exports from the region (MARM, 2007). This explains the relevance of white wine prices among the determinants of adoption.
Most of the dummy variables representing policy changes were not statistically significant, with the exception being the dummy variable representing the year 2001. This specific year has a significant positive impact on the decision to convert suggesting that the introduction of the organic farming logotype motivated further conversion.

Our results suggest that the importance of the environmental over the economic considerations is a basic factor in the decision to adopt. Thus, an increase in the weight of the environmental objectives over the weight of the economic objectives leads to an increase in the hazard. Further, an increase in the weight that farmers attribute to adopting “farming practices which are respectful with the environment” to the detriment of a “rational use of water” decreases the waiting time to convert. Moreover, an increase in the importance of the objective “generate employment in the farmer area” over the objective “preventing the depopulation of rural areas” increases the probability to convert in a shorter time. These results suggest that both the commitment of organic farmers to the preservation of the environment and the generation of economic activity are important determinants to conversion. Previous empirical analyses have shown that organic farming is more labour demanding than conventional agriculture (OECD, 2000). In this line, our results demonstrate that the aspect of generating employment is an important factor for conversion and highlights the social role of the vineyard organic agriculture in Catalonia.

7. Conclusions

Our paper focuses on assessing the determinants of organic farming adoption as well the timing of the conversion decision. We carry out an empirical study using the Duration Analysis (DA) due to its potential to analyze both the decision and diffusion aspects of organic farming adoption. The model is estimated using farm-level data from a sample of both organic and conventional Catalan farms specialized in grape production. Data were collected through a questionnaire carried out in 2008.

The dependent variable used in the DA is the time farmers waited before adopting organic farming as measured by the number of years after the farmers were responsible for farm management. Several explanatory variables were considered representing farmer and farm characteristics, farm management and results, exogenous factors, attitudes and opinions and farmers’ objectives. We used the Analytical Hierarchy Process (AHP) to measure farmers’ objectives and the Principal Components Analysis (PCA) to synthesize information on farmers’ attitudes and opinions.

Several variables are found to increase the hazard of adoption. Farmers who have recently undertaken the management of the farm, who are risk loving, are willing to preserve the
environment and generate employment in their area, are more prone to adopt in a shorter period of time. Small farms that are located in less favored areas and that diversify their production also display higher hazard rates. Farmers receiving higher output prices, who have difficulties in accessing credit and that have a second economic activity besides farming, are more likely to adopt as well. Finally, easy access to information sources, the presence of local agricultural authorities and some policy regulations also motivate higher adoption rates. On the other hand, older farmers whose decisions are mainly based on economic variables and who are running very specialized and big farms, have a low hazard to adopt organic practices.

Our analysis is based on a semi-parametric approach that still requires the parameterization of the risk function. Misspecification of this function will lead to inconsistent results. Our results should thus be interpreted carefully. To overcome this limitation, the literature on the topic has recently proposed the use of local estimation techniques. It would thus be interesting to compare our results with the ones derived from this alternative approach. This task is however beyond the scope of the paper and is proposed for future research.

REFERENCES


Matuschke, I., Qaim, M., 2008. Seed market privatisation and farmers’ access to crop technologies: the case of hybrid pearl millet adoption in India. *Journal of Agricultural Economics, 59(3)*, 498-515.


## Appendix 1: Variables included in the DA model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Mean</th>
<th>St. Dev</th>
<th>Mean</th>
<th>St. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Organic</td>
<td>Conventional</td>
<td>Organic</td>
<td>Conventional</td>
</tr>
<tr>
<td>$f_1$</td>
<td>Age when farmer decides to convert</td>
<td>36.52</td>
<td>9.92</td>
<td>43.75</td>
<td>11.10</td>
</tr>
<tr>
<td>$f_2$</td>
<td>Year when the farm management was undertaken</td>
<td>1993.9</td>
<td>8.12</td>
<td>1989.7</td>
<td>11.1</td>
</tr>
<tr>
<td>$f_3$</td>
<td>If farmer has a secondary economic activity=1; 0 = otherwise</td>
<td>0.65</td>
<td>0.48</td>
<td>0.47</td>
<td>0.50</td>
</tr>
<tr>
<td>$s_1$</td>
<td>Total farm size: in hectares</td>
<td>17.96</td>
<td>12.8</td>
<td>49.07</td>
<td>82.39</td>
</tr>
<tr>
<td>$s_2$</td>
<td>Disfavoured area according to the CAP=1, 0= otherwise</td>
<td>0.53</td>
<td>0.50</td>
<td>0.28</td>
<td>0.45</td>
</tr>
<tr>
<td>$m_1$</td>
<td>Viticulture income as a percentage of total farm income</td>
<td>72.19</td>
<td>29.76</td>
<td>70.11</td>
<td>27.26</td>
</tr>
<tr>
<td>$e_1$</td>
<td>Information source:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$e_{1.1}$</td>
<td>Input suppliers = 1; 0= otherwise</td>
<td>0.57</td>
<td>0.50</td>
<td>0.78</td>
<td>0.41</td>
</tr>
<tr>
<td>$e_{1.2}$</td>
<td>Cooperatives or processors = 1; 0= otherwise</td>
<td>0.34</td>
<td>0.48</td>
<td>0.24</td>
<td>0.43</td>
</tr>
<tr>
<td>$e_{1.3}$</td>
<td>Local agricultural authorities = 1; 0= otherwise</td>
<td>0.65</td>
<td>0.48</td>
<td>0.53</td>
<td>0.50</td>
</tr>
<tr>
<td>$e_{1.4}$</td>
<td>Specialized literature= 1; 0= otherwise</td>
<td>0.76</td>
<td>0.42</td>
<td>0.56</td>
<td>0.49</td>
</tr>
<tr>
<td>$e_2$</td>
<td>Problems in getting loans (0= easy to 10= difficult)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$e_{2.1}$</td>
<td>(difficulty scale &lt; 4) = base level</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$e_{2.2}$</td>
<td>(4 ≤ difficulty scale ≤ 6) =1; 0= otherwise</td>
<td>0.30</td>
<td>0.47</td>
<td>0.51</td>
<td>0.50</td>
</tr>
<tr>
<td>$e_{2.3}$</td>
<td>(difficulty scale &gt; 6) =1; 0= otherwise</td>
<td>0.07</td>
<td>0.27</td>
<td>0.17</td>
<td>0.37</td>
</tr>
<tr>
<td>$e_3$</td>
<td>Price of grape for white wine €/kg</td>
<td>0.55</td>
<td>1.21</td>
<td>0.26</td>
<td>0.19</td>
</tr>
<tr>
<td>$e_4$</td>
<td>Dummy variable for 2001&gt;=1 (0 before 2001) to capture the impact of the introduction of logotype “organic agriculture- control system”</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Exogenous factors $E$

## Attitudes and opinions $(A)$

### PCA results on the perception of economic agents toward organic farming

| $a_2$ | Social Agents | 0.83 | 0.98 | -0.23 | 0.87 |

### PCA results on farmer’s incentives to convert to organic farming

| $a_4$ | Economic motivations | -0.71 | 1.20 | 0.19 | 0.84 |

### PCA results on farmer’s opinions toward organic farming

| $a_6$ | Quality and image | 0.76 | 0.85 | -0.21 | 0.93 |

### Risk attitude in a scale from 0= risk averse to 10= risk loving

| $a_{7.0}$ | (risk attitude scale < 4) = base level | - | - | - | - |
| $a_{7.1}$ | (4≤ risk attitude scale ≤ 6) =1; 0= otherwise | 0.42 | 0.50 | 0.35 | 0.47 |
| $a_{7.2}$ | (risk attitude scale > 6) =1; 0= otherwise | 0.46 | 0.50 | 0.51 | 0.50 |

### Dangerous inputs should be prohibited (0= disagree to 10= agree)

| $a_{8.0}$ | (banning attitude scale < 4) = base level | - | - | - | - |
| $a_{8.1}$ | (4≤ banning attitude scale ≤ 6) =1; 0= otherwise | 0.07 | 0.27 | 0.31 | 0.46 |
| $a_{8.2}$ | (banning attitude scale > 6) =1; 0= otherwise | 0.88 | 0.32 | 0.55 | 0.49 |
Table 1: Studies that analyze organic farming adoption and its determinants

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Size</th>
<th>Method of analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acs et al. (2007)</td>
<td></td>
<td>Dynamic linear programming</td>
</tr>
<tr>
<td>Albisu and Laajimi (1998)</td>
<td>97</td>
<td>Probit Model</td>
</tr>
<tr>
<td>Anderson et al. (2005)</td>
<td>28</td>
<td>Multinomial and Logit model</td>
</tr>
<tr>
<td>Calatrava and González (2008)</td>
<td>254</td>
<td>Ordered Probit model</td>
</tr>
<tr>
<td>Darnhofer et al. (2005)</td>
<td>9</td>
<td>Decision tree modelling</td>
</tr>
<tr>
<td>De Cock (2005)</td>
<td>93</td>
<td>Ordered Probit model</td>
</tr>
<tr>
<td>Fairweather (1999)</td>
<td>16</td>
<td>Decision tree modelling</td>
</tr>
<tr>
<td>Gardebroek and Jongeneel (2004)</td>
<td>16</td>
<td>Bayesian approach</td>
</tr>
<tr>
<td>Genius et al. (2006)</td>
<td>44</td>
<td>Ordered Probit model</td>
</tr>
<tr>
<td>Hanson et al. (2004)</td>
<td>61</td>
<td>Focus group</td>
</tr>
<tr>
<td>Hattam and Holloway (2004)</td>
<td>47</td>
<td>Probit model</td>
</tr>
<tr>
<td>Isin et al. (2007)</td>
<td>20</td>
<td>Probit model</td>
</tr>
<tr>
<td>Kerselaers et al. (2007)</td>
<td>-</td>
<td>Linear programming</td>
</tr>
<tr>
<td>Lohr and Salomonsson (2000)</td>
<td>234</td>
<td>Probit model</td>
</tr>
<tr>
<td>Musshoff and Hirschauer (2008)</td>
<td></td>
<td>Investment under uncertainty</td>
</tr>
<tr>
<td>Parra and Calatrava (2005)</td>
<td>161</td>
<td>Logit model</td>
</tr>
<tr>
<td>Pietola and Oude Lansink (2001)</td>
<td>169</td>
<td>Switching–type Probit</td>
</tr>
<tr>
<td>Rigby and Young (2000)</td>
<td>86</td>
<td>Logit model</td>
</tr>
<tr>
<td>Wossink and Kuminoff (2005)</td>
<td>80</td>
<td>Option theory</td>
</tr>
<tr>
<td>Cisilino and Madau (2007)</td>
<td>115</td>
<td>Data Envelopment Analysis</td>
</tr>
<tr>
<td>Klepper et al. (1977)</td>
<td>14</td>
<td>Basic statistics</td>
</tr>
<tr>
<td>OECD (2000)</td>
<td>-</td>
<td>Basic statistics</td>
</tr>
<tr>
<td>Oude Lansink and Jensma (2003)</td>
<td>29</td>
<td>Profit maximization model</td>
</tr>
<tr>
<td>Serra et al. (2008)</td>
<td>68</td>
<td>Utility maximization model</td>
</tr>
<tr>
<td>Zhengfei et al. (2005)</td>
<td>28</td>
<td>Damage control model</td>
</tr>
</tbody>
</table>

Comparison between organic and conventional studies
Table 2: Direction of the relationship between variables and the decision to adopt

<table>
<thead>
<tr>
<th>Variables</th>
<th>Direction of the effect</th>
<th>Variables</th>
<th>Direction of the effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>+</td>
<td>Risk lover</td>
<td>+</td>
</tr>
<tr>
<td>Age</td>
<td>−</td>
<td>Ease of obtaining information</td>
<td>+</td>
</tr>
<tr>
<td>Gender/woman</td>
<td>+</td>
<td>Experience and skills</td>
<td>−</td>
</tr>
<tr>
<td>Farm size</td>
<td>−</td>
<td>Debt level</td>
<td>−</td>
</tr>
<tr>
<td>Off-farm activities</td>
<td>+</td>
<td>Difficulties in getting loans</td>
<td>−</td>
</tr>
<tr>
<td>Land slope</td>
<td>+</td>
<td>Farm manager urban background</td>
<td>+</td>
</tr>
<tr>
<td>Cold climate</td>
<td>+</td>
<td>Distance between farm and home</td>
<td>−</td>
</tr>
<tr>
<td>Positive attitudes toward conversion</td>
<td>+</td>
<td>Closeness of relatives to the farm</td>
<td>−</td>
</tr>
<tr>
<td>Concerns on soil erosion</td>
<td>+</td>
<td>Number of soil analyses per year</td>
<td>+</td>
</tr>
<tr>
<td>Water availability</td>
<td>+</td>
<td>Use of the internet and e-mails</td>
<td>+</td>
</tr>
<tr>
<td>Soil quality</td>
<td>+</td>
<td>Proximity of the farm to organic farms</td>
<td>+</td>
</tr>
<tr>
<td>Family labor in farm</td>
<td>+</td>
<td>Number of organic farms around</td>
<td>+</td>
</tr>
<tr>
<td>Total labor in farm</td>
<td>+</td>
<td>Course and conference assistance</td>
<td>+</td>
</tr>
<tr>
<td>Number of information sources</td>
<td>+</td>
<td>Membership of an environmental organization</td>
<td>+</td>
</tr>
<tr>
<td>Opinion in favor of preserving the environment</td>
<td>+</td>
<td>Concerns about family health</td>
<td>+</td>
</tr>
<tr>
<td>Member of a producers’ association</td>
<td>+</td>
<td>Policy support</td>
<td>+</td>
</tr>
<tr>
<td>Positive perceptions toward organic farming</td>
<td>+</td>
<td>Concerns about food safety</td>
<td>+</td>
</tr>
<tr>
<td>Concerns about soil degradation</td>
<td>+</td>
<td>Social contact</td>
<td>−</td>
</tr>
</tbody>
</table>

Source: Own elaboration based on literature review shown in Table 1
### Table 3: Results from Principal Component Analysis (PCA) on farmers’ attitudes and opinions

#### Perception of the attitudes of different economic agents toward organic farming

**Variables** | Factor 1 ($a_1$) | Factor 2 ($a_2$)
---|---|---
Consumers | .761 | .033
Retailers | .697 | .139
Banks | .643 | .137
Farmers in your area | .584 | .140
Labor unions | .191 | .820
Membership of a producer organization | .058 | .758
Family members | .138 | .659

Cronbach’ Alfa: 0.68  
KMO Test: 0.68  
Bartrlet Test: 120.17 (0.000)  
Rotation method: Varimax  

Total Explained variance: 51.7%

#### Farmers’ incentives to conversion to organic farming

**Variables** | Factor 1 ($a_1$) | Factor 2 ($a_2$) | Factor 3 ($a_3$)
---|---|---|---
There are positive perspectives for organic products in international markets | .822 | .038 | .171
There are positive perspectives for organic products in national markets | .739 | .090 | .163
With conversion, it is possible to have access to economic support | .201 | .844 | -.093
Inputs in conventional agriculture are more expensive | -.222 | .722 | .457
Diversification of the distribution channels | .446 | .480 | .030
Adoption prevents family health problems from chemicals | .121 | .015 | .847
Adoption brings personal satisfaction | .185 | .056 | .553

Cronbach’ Alfa: 0.623  
KMO Test: 0.60  
Bartrlet Test: 94.82 (0.000)  
Rotation method: Varimax  

Total Explained variance: 61.9%

#### Farmers’ opinions toward organic farming

**Variables** | Factor 1 ($a_1$) | Factor 2 ($a_2$)
---|---|---
Organic farming improves soil fertility and its structure | .767 | .213
Organic products have better quality than conventional ones | .635 | .156
Organic farming gives a positive image to the farm | .570 | .106
Organic products are more healthy than conventional ones | .380 | -.012
Organic price premiums compensate for increased production costs | .183 | .809
Organic farming helps to ensure farm’s economic viability | .409 | .750
Organic farming has more risk due to yield fluctuation | .433 | -.565
The management of organic farming is more flexible than the management of conventional farming | .076 | .485

Cronbach’ Alfa: 0.593  
KMO Test: 0.65  
Bartrlet Test: 152.19 (0.000)  
Rotation method: Varimax  

Total Explained variance: 46.33%
Table 4: Aggregated weights for organic and conventional farmers’ objectives

<table>
<thead>
<tr>
<th></th>
<th>Economic objectives</th>
<th>Environmental objectives</th>
<th>Socio-cultural objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$w_{o1}$</td>
<td>$w_{o2}$</td>
<td>$w_{o3}$</td>
</tr>
<tr>
<td>Aggregated weight (geometric mean)</td>
<td>0.623 0.428</td>
<td>0.241 0.391</td>
<td>0.136 0.181</td>
</tr>
<tr>
<td>Arithmetic mean</td>
<td>0.589 0.416</td>
<td>0.243 0.384</td>
<td>0.160 0.200</td>
</tr>
<tr>
<td>Trimmed mean*</td>
<td>0.691 0.333</td>
<td>0.205 0.333</td>
<td>0.111 0.177</td>
</tr>
<tr>
<td>Variance</td>
<td>0.043 0.029</td>
<td>0.017 0.022</td>
<td>0.023 0.013</td>
</tr>
<tr>
<td>Median</td>
<td>0.644 0.418</td>
<td>0.249 0.335</td>
<td>0.107 0.167</td>
</tr>
</tbody>
</table>

*Computed discarding the 25% lowest scores and the 25% highest ones.

Table 5: Proportions of the relative weights of primary and secondary included in the DA model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Mean Organic</th>
<th>St. Dev</th>
<th>Mean Conventional</th>
<th>St. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>$w_{o2}$</td>
<td>Relative weight between “environmental” and “economic” objectives</td>
<td>3.77</td>
<td>4.32</td>
<td>7.35</td>
<td>5.61</td>
</tr>
<tr>
<td>$w_{o3}$</td>
<td>Relative weight between “economic” and “socio-cultural” objectives</td>
<td>1.49</td>
<td>1.75</td>
<td>5.87</td>
<td>22.52</td>
</tr>
<tr>
<td>$w_{o2}$</td>
<td>Relative weight between “environmental” and “socio-cultural” objectives</td>
<td>0.58</td>
<td>0.38</td>
<td>0.96</td>
<td>1.38</td>
</tr>
</tbody>
</table>

**Farmer primary objectives ($O_i$)**

| $w_{o1}$ | Relative weight between “maximize vineyard sales” and “maximize total farm income from agricultural and non-agricultural activities” | 0.80 | 2.02 | 0.61 | 1.23 |
| $w_{o1}$ | Relative weight between “maximize vineyard sales” and “maximize profits” | 0.55 | 0.67 | 1.02 | 3.24 |
| $w_{o2}$ | Relative weight between “maximize total farm income from agricultural and non-agricultural activities” and “maximize profit” | 2.79 | 2.55 | 3.04 | 2.52 |

**Economic secondary objectives**

| $w_{o2}$ | Relative weight between “promoting environmentally friendly farming practices” and “maintain soil fertility” | 1.19 | 1.89 | 1.29 | 3.05 |
| $w_{o2}$ | Relative weight between “promoting environmentally friendly farming practices” and “rational use of water” | 1.15 | 1.27 | 1.23 | 1.96 |
| $w_{o2}$ | Relative weight between “maintain soil fertility” and “rational use of water” | 2.06 | 2.87 | 2.40 | 2.90 |

**Environmental secondary objectives**

| $w_{o3}$ | Relative weight between “generate employment in the farmer area” and “keep the existing socio-cultural values” | 3.11 | 2.02 | 2.74 | 2.97 |
| $w_{o3}$ | Relative weight between “generate employment in the farmer area” and “prevent the depopulation of rural areas” | 7.33 | 6.34 | 4.6  | 4.7   |
| $w_{o3}$ | Relative weight between “keep the existing socio-cultural values” and “prevent the depopulation of rural areas” | 2.74 | 2.38 | 2.94 | 3.70 |
Table 6: Results from partial likelihood estimation for COX proportional Hazard model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter</th>
<th>Std. Error</th>
<th>P-value</th>
<th>Hazard Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative weight between “environmental” and “economic” objectives</td>
<td>0.721**</td>
<td>0.315</td>
<td>0.022</td>
<td>2.056</td>
</tr>
<tr>
<td>Relative weight between “promoting environmentally friendly farming practices” and “rational use of water”</td>
<td>0.235***</td>
<td>0.078</td>
<td>0.003</td>
<td>1.265</td>
</tr>
<tr>
<td>Relative weight between “generate employment in the farmer area” and “prevent the depopulation of rural areas”</td>
<td>0.683***</td>
<td>0.249</td>
<td>0.006</td>
<td>1.981</td>
</tr>
<tr>
<td>Age at conversion</td>
<td>-0.279***</td>
<td>0.062</td>
<td>0.000</td>
<td>0.757</td>
</tr>
<tr>
<td>Year when management responsibility was assumed</td>
<td>0.127**</td>
<td>0.050</td>
<td>0.011</td>
<td>1.135</td>
</tr>
<tr>
<td>If farmer has a secondary activity = 1; 0 = otherwise</td>
<td>2.548**</td>
<td>0.924</td>
<td>0.006</td>
<td>12.785</td>
</tr>
<tr>
<td>Percentage of total farm income coming from viticulture</td>
<td>-0.028*</td>
<td>0.016</td>
<td>0.085</td>
<td>0.973</td>
</tr>
<tr>
<td>Total farm size</td>
<td>-0.083***</td>
<td>0.029</td>
<td>0.000</td>
<td>0.921</td>
</tr>
<tr>
<td>Disfavoured area according to the CAP = 1, 0 = otherwise</td>
<td>1.516**</td>
<td>0.718</td>
<td>0.035</td>
<td>4.556</td>
</tr>
<tr>
<td>Local agricultural authorities as information source = 1; 0 = otherwise</td>
<td>4.442***</td>
<td>1.372</td>
<td>0.001</td>
<td>84.932</td>
</tr>
<tr>
<td>Difficulties in getting loans, Likert scale &gt; 6 = 1; 0= otherwise</td>
<td>2.773**</td>
<td>1.226</td>
<td>0.024</td>
<td>16.007</td>
</tr>
<tr>
<td>Price of grape for white wine €/kg.</td>
<td>0.900***</td>
<td>0.306</td>
<td>0.003</td>
<td>2.459</td>
</tr>
<tr>
<td>Dummy variable for 2001 = 1, 0 prior to 2001.</td>
<td>4.298***</td>
<td>1.606</td>
<td>0.007</td>
<td>73.533</td>
</tr>
<tr>
<td>Dummy variable for subjective risk attitude’ scale &gt; 6 = 1; 0 = otherwise (Likert scale from 0: the farmer undertakes no risk to 10 the farmer undertakes high risks)</td>
<td>2.318**</td>
<td>0.983</td>
<td>0.018</td>
<td>10.155</td>
</tr>
<tr>
<td>Dummy variable for the Opinion on banning of dangerous inputs scale &gt; 6 =1; 0= otherwise (Likert scale from 0 = totally disagree to 10 = completely agree)</td>
<td>2.325***</td>
<td>0.854</td>
<td>0.007</td>
<td>10.225</td>
</tr>
<tr>
<td>PCA results: Positive perception of “Social agents” toward organic farming</td>
<td>1.124**</td>
<td>0.513</td>
<td>0.028</td>
<td>3.078</td>
</tr>
<tr>
<td>PCA Results: economic motivations to convert</td>
<td>-1.424***</td>
<td>0.440</td>
<td>0.001</td>
<td>0.241</td>
</tr>
<tr>
<td>PCA results: Quality and positive image of organic products</td>
<td>1.553***</td>
<td>0.508</td>
<td>0.000</td>
<td>4.723</td>
</tr>
</tbody>
</table>

Likelihood Ratio: 122.5003 (0.000), Akaike Information criterion=123.575
Wald test: 35.2669 (0.0087), Schwarz Information Criterion=144.780
Lagrange Multiplier Test: 94.3136 (0.000)

Significance levels: ***p < 0.01; **p < 0.05; *p < 0.10.
Determinants of organic farming adoption

- Farmers' attitudes and opinions
- Farmers' objectives
- Farmers' characteristics
- Farms' characteristics
- Farm management and results
- Exogenous factors

Focus Groups

Principals Components Analysis (PCA)
Analytical Hierarchy Process (AHP)

Duration Analysis (DA)

**Figure 1:** Methodological Diagram

Farmers' objectives

- Economic ($o_1$)
  - $o_{1,1}$
  - $o_{1,2}$
  - $o_{1,3}$
- Environmental ($o_2$)
  - $o_{2,1}$
  - $o_{2,2}$
  - $o_{2,3}$
- Socio-cultural ($o_3$)
  - $o_{3,1}$
  - $o_{3,2}$
  - $o_{3,3}$

**Figure 2:** Hierarchical structure used to value conventional and organic farmers' objectives
Figure 3: Results of the Hierarchical structure of conventional and organic farmers’ objectives

- **Economic** $w_0^1$
  - Conv: 62.31%
  - Org: 42.80%
- **Environmental** $w_0^2$
  - Conv: 24.08%
  - Org: 39.12%
- **Socio-cultural** $w_0^3$
  - Conv: 13.62%
  - Org: 18.08%

**Wo1.1**: maximize vineyard sales.
**Wo1.2**: maximize total farm income from agricultural and non-agricultural activities.
**Wo1.3**: maximize profit.

**Wo2.1**: promoting environmentally friendly practices.
**Wo2.2**: maintain soil fertility.
**Wo2.3**: rational use of water.

**Wo3.1**: generate employment in the farmer area.
**Wo3.2**: preserve the existing socio-cultural values.
**Wo3.3**: prevent the depopulation of rural areas.