

The 83rd Annual Conference of the Agricultural Economics Society

Dublin

30th March to 1st April 2009

Adoption and Abandonment of Organic Farming An Empirical Investigation of the Irish Drystock Sector

Doris Läpple^{1,2} and Trevor Donnellan²

¹ Department of Economics, National University of Ireland, Galway; Doris.Laeppl@teagasc.ie

² Rural Economy Research Centre, Teagasc, Athenry, Co. Galway

Summary

The adoption and possible abandonment of organic farming has yet received little attention in the literature. As time plays an important role in explaining farming decisions, a dynamic econometric framework, namely duration analysis, is used. The probability of entry to and exit of the organic drystock sector is modeled considering a wide range of economic and non-economic factors. Organic support payments emerge as important driving factor of adoption over time. The empirical results also highlight the importance of environmental and risk attitudes, farming experience as well as influence of other organic farmers on the probability to adopt organic farming; whereas decisions to abandon organic farming appear to be mainly driven by economic and structural factors. Farmers who have an off-farm job are more likely to abandon organic farming and a more 'intensive' farm system has a positive effect on staying organic.

Keywords: adoption, abandonment, organic farming, duration analysis, economic and non-economic factors.

Copyright 2009 by Doris Läpple and Trevor Donnellan. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

1. Introduction

Although the organic farming sector in Ireland is growing steadily, it remains small in comparison to other European countries. Due to the recent government target of having 5% of the agricultural area in organic farming by 2012, the organic farming sector is receiving more attention through changes in support payments and increased provision of agronomic advice. The objective of this study is to determine the economic and non-economic factors that influence entry and exit decisions into organic farming. Once organic farming is adopted, the farmer may reverse the decision if the benefits from organic farming are less than expected. However, the reasons why farmers abandon organic farming have received less attention and may provide further insight towards understanding the slow uptake of organic farming in Ireland.

Whereas the majority of the literature focuses on the adoption of a technology, few studies explain both, adoption and abandonment. One of the few examples are Walton *et al* (2008) who explore factors motivating adoption and abandonment of precision soil sampling in cotton production in the U.S. using a probit model. In terms of exit from organic farming, a study by Rigby and Young (2001) explores reasons for reversion from organic farming in the UK using a logit model. Although these studies explore both, adoption and abandonment, an important component, the inclusion of time is missing.

Using a dynamic econometric framework, duration analysis, has the advantage in comparison to static logit/probit models that it is possible to incorporate time in the decision process. Time plays an important role in explaining farming decisions, as it captures a number of influences which shift the costs of adoption or abandonment, such as changes in the economic environment or learning from others.

Recently duration analysis has become more popular in the agricultural economics literature in explaining the time it takes a farmer to adopt a certain technique. For instance, DeSouza Filho *et al* (1999) explain the adoption of sustainable agricultural techniques in Brazil using duration analysis. A study by Hattam and Holloway (2007) explores the time to adoption of organic farming for small scale Mexican avocado producers using a Bayesian approach. The only European study explaining the time to adoption of organic farming appears to be Burton *et al* (2003). They model the time it takes a farmer to adopt organic horticultural techniques in the UK. Looking at adoption and abandonment decisions over time, the study by Carletto *et al* (1999) seems to be the only one in the agricultural economics literature. They investigate adoption and withdrawal of smallholder nontraditional agro-exports in Guatemala

using duration analysis. However there is a dearth of research considering the adoption and the subsequent abandonment of organic farming. Therefore, this study aims to fill this gap, by firstly including the exit from organic farming and accounting for changes over time using a duration analysis modeling approach.

The paper is structured as follows: In the next section impacts on the development of organic farming are briefly outlined. In section three the data are described; in section four the applied methodology is explained and the different approaches for the entry and exit model are outlined; in section five results are presented and discussed, while some final conclusions are drawn in section six.

2. Impacts on the development of organic farming

The study area

The introduction in Ireland of the Rural Environmental Protection Scheme (REPS) with the Supplementary Measure 6 for organic farming in June 1994 made organic farming economically more attractive and caused a strong uptake in the organic sector. For example, organic farm numbers increased from 300 in 1995 to 852 in 2000 (Moran and Connolly, 2007). Currently about 1,300 organic farmers operate 1% of the agricultural area. Despite of the steady growth of the sector, more than 200 farmers left organic farming between 2003 and 2006. Since August 2007 the new Organic Farming Scheme has been in operation. Due to changes in the organic regulations and higher support payments, a growth of the sector is expected. Furthermore, greater emphasis is being placed on the organic farming advisory service, with an increase in the number of organic farm advisors and information events.

About 80% of the organic farms are drystock farms¹, followed by horticultural enterprises accounting for about 10-15%, with tillage, dairy and poultry farms making up the remainder (DAFF, 2002). Due to the extensive, mainly grass based nature of Irish drystock systems; many farmers could easily switch to organic farming without high entry costs. Ireland is currently self-sufficient in organic beef but an export market, mainly to the UK is emerging. A considerable part of organic produce is sold as conventional, which indicates a lack of organic markets. For instance, currently up to 50% of weanlings and store cattle are lost to conventional markets.

¹ The required numbers for an empirical study and the scale of the government land area target, justify the focus on the drystock sector.

Entry decisions over time

In general a farmer is expected to adopt organic farming when the expected utility from organic farming exceeds the utility received from conventional farming. Economic considerations are regarded as key drivers, but in terms of participation in environmental schemes and adoption of organic farming, the literature widely agrees that personal factors such as attitudes and objectives of the farmer have an important impact on that decision (e.g. Lynne *et al*, 1988; DeFrancesco *et al*, 2008). For example, Battershill and Gilg (1997) identified attitudes as more important on the decision to adopt environmental friendly practices than structural constraints. Whereas time in general may have a positive impact on adoption of organic farming due to better economic or social circumstances, the probability to adopt organic farming is expected to decrease with increasing time spent in farming. This is due to the increasing age of the farmer, which is associated with a decreasing willingness to adopt a new technology.

Exit decisions over time

Once a farmer has adopted organic farming, the realized utility from organic farming is assessed in order to decide whether or not to continue organic farming. In terms of timing of exit one important factor emerges: The receipt of organic farming support payments is based on a five year contract. Leaving the support scheme early results in the requirement to pay back the subsidies received. Therefore it is expected that the farmer either leaves immediately or at year five, with a decreasing probability to exit thereafter, unless unexpected changes in the (economic) environment occur. Considering other factors, it is assumed that similar factors influence exit decisions (mainly with the opposite sign) than do entry decisions.

In conclusion there are a variety of reasons why a farmer would adopt or abandon organic farming. Factors can broadly be divided in structural, economic, farmer characteristics, information and social learning as well as attitudes and objectives of the farmer. This empirical study will help to identify what roles these factors play in the entry and exit decisions of farmers.

3. Survey data

Questionnaire

The study is based on a nationwide cross-sectional survey for Ireland which was conducted between July and November 2008. The questionnaire covered the following topics: (a) general information, e.g. farming experience, (b) farm characteristics, (c) characteristics of farm operator and household, (d) sources and frequency of information use, (e) attitudes and objectives, (f) reasons for conversion or dropping out of organic farming and (g) economics of the farm enterprise.

Since the numbers of organic and ex-organic farmers are very small in Ireland, random sampling would not have created a large enough number of organic and ex-organic farmers for an empirical analysis. For the organic and the ex-organic farmers complete lists were available. A survey was sent to each farmer in these groups. A response rate of 40% for the organic farmers and 22% for the ex-organic farmers was achieved with an announcement of the survey in the Irish Farmers' Journal newspaper and after one reminder letter was sent. The data for the conventional farmers were collected through farms in the Teagasc National Farm Survey, which is a representative sample of Irish farms. After restriction of the analysis to drystock farmers and elimination of questionnaires with missing data, the final sample consisted of 341 organic, 40 ex-organic and 164 conventional farmers.

Data description

In the sample the earliest observed entry to start farming was in 1936 and the earliest adoption of organic farming occurred in June 1981; the first ex-organic farmer began organic farming in May 1984. Over 90% of farmers in the sample adopted after the implementation of REPS in June 1994. The first exit of organic farming occurred in June 1998. In Figure 1 entry years into organic farming across the sample are presented, decomposed between organic and ex-organic farmers.

The longest observed time in farming until adoption of organic farming was 56.7 years, with an average duration until adoption of 13.4 and 9.4 years for the organic and ex-organic farmers, respectively. Looking at the ex-organic farmers the average time spent in organic farming was 7.4 years, with the shortest duration of 8 months and the longest observed period 18.7 years.²

² All included farmers are still farming, but the age of this farmer was over 70 years, therefore the exit decision after 18 years might be closely related to a retirement decision. Exclusion of farmers over 65 years did not alter results significantly, therefore due to few ex-organic farmers in the sample all farmers regardless to their age were kept in the analysis.

Figure 1: Start of organic farming for organic and ex-organic farmers in sample, 1981-2008.

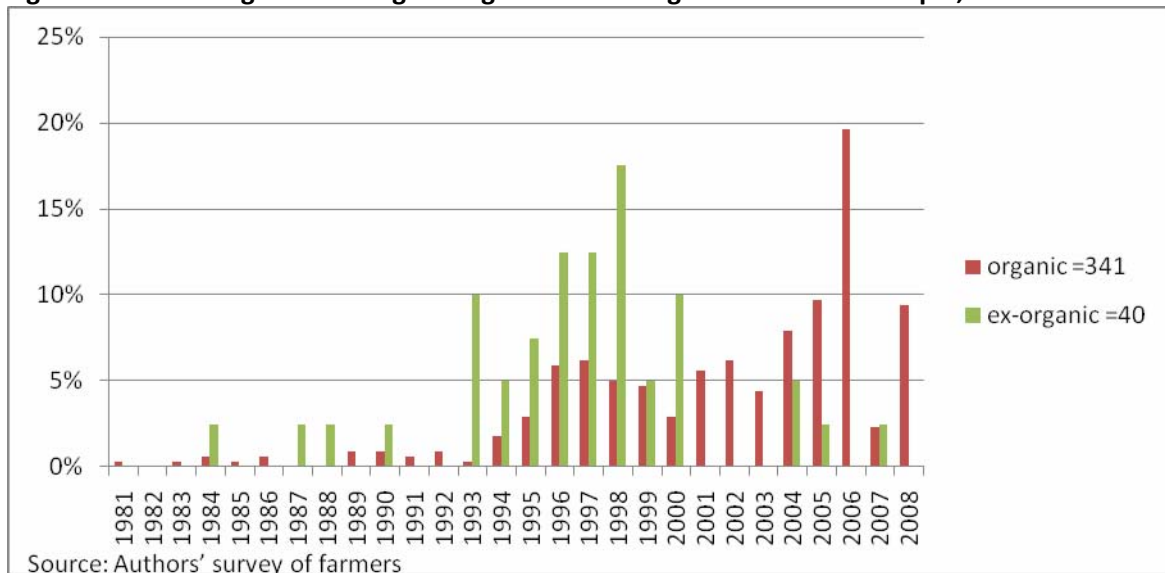


Table 1 provides summary statistics of variables included in the analysis. The choice of explanatory variables is based on a literature review and on the availability of data. Most of the variables are self-explanatory, but some need further clarification.

The variable future captures the expected development of the farm within the next 10 years and includes succession plans as well as future planning of the farm (DeFrancesco *et al*, 2008). This variable avoids measuring problems of succession for younger farmers, but also captures further planning horizons.

Five attitudinal variables are included in the analysis. Each of the attitudinal variables consists of several statements, which were extracted using principal component analysis. The initial statements were measured on a seven-point Likert scale.

Table 1: Descriptive statistics of explanatory variables for the sample (545 farmers)

Variable	Description	Organic	Ex-organic	Conventional
		(341)	(40)	(164)
		Mean (st.dev.)	Mean (st.dev.)	Mean (st.dev.)
uaa	Utilizable agricultural area in ha	36.15 (23.37)	32.17 (41.88)	54.60 (39.95)
lutotal	Livestock units (LU)	31.39 (24.43)	21.07 (24.43)	61.69 (63.02)
luh	LU/hectare	0.80 (0.90)	0.54 (0.46)	-
	LU/UAA ³	0.94 (0.71)	0.69 (0.50)	1.13 (0.52)
labour	Total labour units	1.05 (0.60)	0.72 (0.58)	1.15 (0.46)
ofw1	Farm operator works off-farm 0= no, 1 = yes	0.44 (0.50)	0.73 (0.45)	0.31 (0.46)
hhmemb	Number of household members	3.42 (1.63)	3.45 (1.85)	3.31 (1.69)
farmex	Farming experience at adoption (in years)	22.44 (12.71)	18.70 (12.10)	34.94 (12.68)
gender	Gender 0=female, 1 = male	0.86 (0.35)	0.85 (0.36)	0.96 (0.20)
ed	Level of education of farm operator 1= primary school 2= inter cert (=leaving school at the age of 16) 3 = leaving cert (= finished secondary school) 4 = third level 5 = post graduate 6 = other	3.09 (1.27)	3.33 (1.21)	2.83 (0.74)
future	Expected development of farm in next 10 years 1= sold/rented out for non- agricultural purposes 2= managed by successor 3= business as usual 4= expand farm business 5= other 6= don't know	3.48 (1.12)	3.43 (1.53)	3.04 (1.05)
infnumb	Number of different information sources used	4.01 (1.60)	3.05 (1.63)	3.22 (1.23)
FAtype	Type of farm advisor consulted 0= no farm advisor 1= organic farm advisor 2= conventional farm advisor 3 = both	0.84 (0.87)	0.85 (0.98)	0.99 (1.00)
membnu	Number of memberships of farmer organizations	0.69 (0.72)	0.68 (0.66)	1.07 (0.78)
knowof	If farmer knows other organic farmer 0= no, 1 = yes	0.87 (0.34)	0.80 (0.41)	0.33 (0.47)

³ Different measures occur as only UAA was available for conventional farmers at the time of data analysis.

(Table 1 continued)

Variable	Description	Organic Mean (st.dev.)	Ex-organic Mean (st.dev.)	Conventional Mean (st.dev.)
env	Environmental attitude (-3 to +3) +3 = high environmental concern	2.22 (0.65)	2.16 (0.81)	0.50 (0.82)
profit	Innovative profit orientation (-3 to +3) +3= high profit motivation	1.57 (1.11)	1.52 (1.02)	1.96 (0.71)
inf	Information attitude (-3 to +3) +3 = high information seeking attitude	1.99 (0.88)	1.84 (1.05)	1.60 (0.88)
risk	Risk in decision making (-3 to +3) +3 = risk averse	1.05 (1.23)	0.72 (1.09)	1.40 (0.89)
sn	Influence of others (-3 to +3) +3 = farmer is influenced by others	0.36 (1.45)	0.42 (1.45)	0.35 (1.24)

Due to availability of data and relevance of variables, slight differences occur in the explanatory variables in the entry and exit models. Additional variables included in the exit model are reported in Table 2.

Table 2: Descriptive statistics of additional explanatory variables in the exit model

Variable	Description	Organic 341	Ex-organic 40
provinced1	Connaught (%)	25	35
provinced2	Leinster (%)	22	41
provinced3	Munster (%)	46	35
provinced4	Ulster ⁴ (%)	7	10
	Decision to adopt was influenced by...	Mean (st.dev.)	Mean (st.dev.)
ifad	...farm advisor; 0=no, 1=yes.	0.13 (0.35)	0.15 (0.36)
iofd	...other farmer; 0=no, 1=yes.	0.24 (0.43)	0.22 (0.42)
iotherd	...other source; 0=no, 1=yes.	0.18 (0.38)	0.23 (0.42)
irepsd	...REPS advisor; 0=no, 1=yes.	0.29 (0.46)	0.33 (0.47)
iocbd	...organic certification body; 0=no, 1=yes.	0.10 (0.30)	0.15 (0.36)
ipd	...press; 0=no, 1=yes.	0.32 (0.47)	0.15 (0.36)

⁴ Northern-Ireland not included.

4. Methodology

Duration analysis is used to model entry and exit decision as a process of choice of when to adopt and when to abandon. In this approach the variable of interest is the length of time until a certain event occurs or until the measurement is taken (Greene, 2003). The main interest lies in the probability that a farmer will adopt/abandon organic farming at time t , given the farmer has not adopted/abandoned at that time.

The hazard function and the survivor function are the key concepts and they are related in a one-to-one relationship. Let T be a nonnegative continuous random variable representing the length of a spell with a probability density function $f(t)$ and a cumulative distribution function $F(t)$. $F(t) = \Pr(T \leq t)$ is also known as the failure function (Jenkins, 2004). The survivor function $S(t)$ gives the probability that the spell is at least of length t , which means the probability of surviving beyond time t . The survivor function is given by

$$S(t) = 1 - F(t) = \Pr(T > t). \quad (1)$$

The survivor function equals one at $t = 0$ and strictly decreases towards zero as t goes to infinity. This shows the underlying assumption that all observations will eventually end in an event. Usually at the time of measurement not all spells are completed. Since the spell end dates for these observations are unknown, right censoring at the time t of data collection is necessary. The only thing that is known about a censored observation is that the completed spell is of length $T > t$. Right censoring does not cause any problems in the estimation process, which will be shown later.

The density function $f(t)$ is the slope of the failure function $F(t)$ but can also be obtained from $S(t)$:

$$f(t) = \frac{dF(t)}{dt} = \frac{d}{dt} \{1 - S(t)\} = -S'(t). \quad (2)$$

The hazard function $h(t)$ is the instantaneous rate of failure. As mentioned earlier, this function is of main interest. It provides the probability that the event will end in the next short interval Δt , conditional on survival up to that time,

$$h(t) = \lim_{\Delta t \rightarrow 0} \frac{\Pr(t + \Delta t > T > t | T > t)}{\Delta t} = \frac{f(t)}{S(t)}. \quad (3)$$

The hazard function can vary from zero to infinity and the shape is determined by the underlying process. Whereas in non- or semi-parametric models the hazard function is left unspecified, parametric models require specifying a functional form for the hazard. This means that assumptions about the form of the hazard function have to be made prior to the estimation.

The entry model

Assuming all farmers are aware of organic farming and organic farming was always available to the farmer, the date when the farmer started farming as the main farm holder was used as start of the observation period ($t = 0$). The end of the spell is either the date when the farmer adopted organic farming⁵ or, for the conventional farmers, spells are right censored at the time of data collection. A continuous time specification is used, as spells are measured in days (Jenkins, 2004). A parametric framework, a Weibull model, with the following hazard function is applied:

$$h(t, X) = pt^{p-1} \exp(\beta'X) \tag{4}$$

where p ($p > 0$) is a shape parameter estimated from the data. The hazard rises monotonically for $p > 1$, decreases monotonically for $p < 1$, and reduces to the exponential model with a constant hazard for $p = 1$. The scale parameter is parameterized as $\exp(\beta'X)$. This is a widely used specification as it takes only positive values without making restrictions on β' . The covariates act multiplicatively on the baseline hazard and specifications of this type are known as a proportional hazard models (Kalbfleisch and Prentice, 2002).

Estimation of the parameters follows maximum likelihood procedures. The estimation is complicated by the censoring process. Let E be the set of uncensored episodes and Z stands for the set of censored episodes. This leads to the following likelihood function

$$L = \prod_{i \in E} f(t_i) \prod_{i \in Z} S(t_i) \tag{5}$$

where independence over i has been assumed (Cameron and Trivedi, 2005). The contribution to the likelihood of completed spells, is given by the density function $f(t_i)$ evaluated at the ending time t_i and with equivalent covariate values. The second part of the term represents the right-censored cases. The contribution to the likelihood is given by the survivor function $S(t_i)$ calculated at the censored ending

⁵ The date when the farmer started the conversion period is used.

time t_i and with appropriate covariate values. Incorporating a time dependent dummy variable leads to a split of the spell in two subepisodes. As only $S(t)$ is influenced, the survivor function becomes a product of the conditional survivor functions for each subepisode:

$$S(t) = \prod_{l=1}^L S(t_l | s_l) \quad (6)$$

where s and t are starting and ending times and $l = 1, \dots, L$ stands for the number of subepisodes. Incorporating the conditional survivor function, the previous likelihood function can be used to estimate the coefficients (Blossfeld *et al*, 2007).

The exit model

In the exit model, the beginning of a spell is the date when the farmer adopted organic farming ($t = 0$). The end of a spell is either the date when the farmer dropped out of organic farming or, for the organic farmers, spells are right censored at the time of data collection. A semi-parametric approach is chosen due to firstly an expected non-monotonic shape of the hazard function⁶ and secondly few completed observations. The Cox proportional hazards model is used as this model requires no assumptions about the shape of the hazard function (Jenkins, 2004). The following common specification for the hazard function was chosen (Kalbfleisch and Prentice, 2002):

$$h(t, X) = h_0(t) \exp(\beta'X). \quad (7)$$

The hazard rate $h(t, X)$ is the product of an unspecified baseline hazard $h_0(t)$ and a second term $\exp(\beta'X)$ incorporating the influences of covariates on the hazard rate (Blossfeld *et al*, 2007). In general the coefficients in the Cox-model are estimated using partial-likelihood estimation of the following form:

$$L^P = \prod_{i \in E} \frac{\exp(\lambda_i(t_i)\beta)}{\sum_{j \in R(t_i)} \exp(\lambda_j(t_i)\beta)}, \quad (8)$$

where E is the set of all uncensored episodes and $R(t_i)$ denotes the risk set at the ending time t_i of the i th episode contained in E . The risk set is the set of all episodes, ending with an event or being censored, with starting time less than t_i and ending time $\geq t_i$ (Blossfeld *et al*, 2007). However, in the case of tied observations, problems with the estimation can arise. There are several ways to handle tied

⁶ Further modeling work is still in progress.

observations. Following Kalbfleisch and Prentice (2002) with only few ties in the data, the Breslow method is the preferred specification due to its simple form:

$$L = \prod_{j=1}^k \frac{\exp[\beta_j(t_j) \beta]}{(\sum_{i \in R(t_j)} \exp[\beta_j(t_j) \beta])^{d_j}} \quad (9)$$

Suppose that $t_1 < \dots < t_k$ are the distinct failure times and d_j items fail at time t_j , $j = 1, \dots, k$ and $s_j(t_j)$ is defined as the sum of covariate vectors for the d_j episodes observed to fail at t_j .

5. Results and discussion

The entry model

The results from the estimated Weibull models are presented in Table 3⁷. Three alternative specifications of the model are considered. Model 1 contains all explanatory variables. Model 2 and Model 3 exclude explanatory variables which are not significant. Additionally, in Model 2 the time-varying dummy variable is left out, to see if and how this variable changes the model. Using an Akaike Information Criteria the preferred model between the two Models is Model 3, which also shows the larger log-likelihood. Therefore the following discussion will mainly focus on Model 3. Covariates are reported as hazard ratios ($\exp(\beta_i)$). In terms of interpretation a value greater than one has a positive impact on the hazard of adoption, a value less than one has a negative impact and a value of one means no impact.

Looking at first at the scale parameter (ρ) all models show a decreasing hazard of adoption over time. The decrease in the probability of adoption with increase in the time spent farming, was expected and is in line with the finding of Burton *et al* (2003) who identify a strong negative duration dependence on the adoption of organic farming in the UK.

The time-varying dummy variable (repsd) captures the time before and after the introduction of organic subsidies, switching from zero to one at the date of introduction and therefore allows for an epoch shift. As expected, the implementation of REPS in June 1994 shows a very strong positive impact on the

⁷ Subsequently more detailed variables such as the amount of subsidies received, the development of prices over time and dummy variables for regional influences will be added to the analysis, but this data has yet to be compiled for use in the study.

hazard; this is not very surprising as organic support payments made organic farming financially more attractive and less risky.

Table 3: Estimates of Weibull hazard functions

	Model 1	Model 2	Model 3
	Hazard ratio	Hazard ratio	Hazard ratio
repsd	17.22 (0.000)**	not included	14.79 (0.000)**
uaa	1.00 (0.778)		
lutotal	0.99 (0.004)**	0.99 (0.016)**	0.99 (0.000)**
luh	1.01 (0.918)		
labour	1.08 (0.448)		
ofw1	1.02 (0.885)		
hhmemb	0.99 (0.874)		
farmex	0.97 (0.000)**	0.95 (0.000)**	0.98 (0.000)**
sex1	0.92 (0.620)		
ed	n.s.		
future	n.s.		
infnumb	n.s.		
FAtype1	1.01 (0.976)	1.18 (0.168)	
FAtype2	0.73 (0.065)*	0.72 (0.023)**	
FAtype3	1.01 (0.969)	1.06 (0.806)	
membn	n.s.		
knowof1	1.55 (0.009)**	1.61 (0.003)**	1.67 (0.001)**
env	1.63 (0.000)**	1.58 (0.000)**	1.71 (0.000)**
profit	0.95 (0.384)		
risk	0.90 (0.033)**	0.90 (0.020)**	0.90 (0.018)**
inf	0.98 (0.824)		
sn	1.04 (0.424)		
p	0.62	0.80	0.64
Log Likelihood	-631.41	-820.13	-649.72

Values in brackets are p-values; where one equals no impact; *P<0.1; **P<0.05.

Values for non-significant dummy variables in all models are not reported.

Looking at the structural variables (uaa, lutotal, luh, labour), only livestock units (lutotal) shows a significant effect, though the impact on the hazard (0.99) is very small. The size of the farm measured in utilizable agricultural area (uaa) is not significant. Although farm size is regarded as an important determinant of adoption decisions (e.g. Feder *et al*, 1985), other studies measuring time to adoption of organic farming found farm size as not significant as well (Burton *et al*, 2003; Hattam and Holloway, 2007). Total labour units (labour) and livestock density (luh) were expected to have a negative impact, but are found not to be significant on the hazard of adoption. DeFrancesco *et al* (2008) found total labour supply on the farm as a constraint in participation in environmental schemes. Livestock density

serves as a measure of farming intensity. Entry in environmental schemes is associated with more extensive farming systems, due to lower entry costs. For instance, a higher stocking density was found to delay entry in environmental schemes (Wynn *et al*, 2000). Due to the extensive nature of Irish drystock farms, adjustments on the farm are expected to be low, which may explain that these variables are found not to be significant.

The only economic variable included in this study, if the farmer has an off-farm job (ofw1), does not have a significant impact on the hazard of adoption of organic farming. This finding is in line with the results of Burton *et al* (2003) and Genius *et al* (2006). Both studies found off-farm income not significant on adoption of organic farming. On the one hand, having an off-farm income increases freedom in farm decision making, due to lower dependency on farm income, but on the other hand it limits the time a farmer can spend on the farm, which is expected to have a negative effect on going organic.

Looking at the variables that describe farmer characteristics and household, farming experience (farmex) was the only variable that shows a significant impact. The effect has the expected negative influence. Organic farmers have in general less farming experience than conventional farmers (Padel, 2001). Farming experience is also closely related to age and younger farmers were found to adopt first (Hattam and Holloway, 2007). The number of household members (hhmemb) and education (ed), which were expected to positively shift the hazard, are not significant. In general education is regarded as an important variable in technology adoption (e.g. Feder *et al*, 1985) with better educated farmers having a higher probability to adopt a new technology. This finding was confirmed by Hattam and Holloway (2007) with higher educated farmers more likely to adopt first; but other studies (Burton *et al*, 2003; Genius *et al*, 2003) found education not to be significant on adoption of organic farming. Unlike to Burton *et al* (2003) gender (sex1) turned out to be not significant, but due to very few female farmers the possible influence would have been questionable anyway. Future planning of farm development, which also captures having a successor (future) is found not significant as well. It is widely agreed in the literature that concerns about succession affect adoption decisions (e.g. Walton *et al*, 2008; Wilson, 1996). Having no successor positively impacts farming conservation (Battershill and Gilg, 1997), but the decision to adopt organic farming may be more dependent on the expected future profitability than it is on having a successor. A similar result was found by DeFrancesco *et al* (2008) who demonstrate that highly market oriented farmers are more likely to be resistant non adopters of environmental schemes.

In Model 3 both variables measuring the influence of information are not significant. Number of different information sources (infnumb) used serves as a proxy of how much information a farmer uses.

Following previous findings (Genius *et al*, 2006), a higher number of different information sources consulted was expected to have a positive impact on adoption. Different types of farm advisors (FAtype) have an impact on the hazard of adoption in Model 2. Interestingly, consulting a conventional farm advisor (FAtype2) reduces the hazard rate of adoption relative to not consulting a farm advisor at all. Consulting an organic farm advisor (FAtype1) or both types of farm advisors (FAtype3) have a positive impact, though not significant. Hattam and Holloway (2007) found a negative impact of agronomists on the time of adoption of organic avocado production in Mexico. They argue that a small number of agronomists trained in organic farming and an absence of widespread information are the reasons for that negative impact, which is similar to the situation in Ireland.

In terms of social influences, the variable denoting whether the farmer knows another organic farmer (knowof1) shows the expected positive impact on the hazard of adoption, whereas the number of different memberships in farmer organizations (membnu) is not significant. Existing organic farmers are an important source of information and expertise for farmers converting (Padel and Lampkin, 1994). For instance, Hattam and Holloway (2007) found knowing an organic farmer not significant but found a positive influence of talking to an organic farmer on the probability of conversion to organic farming.

Looking at the attitudinal variables; environmental and risk attitude show a significant influence on the probability of adoption. As expected, high environmental concern (env) has a positive impact on adoption. This is in line with previous findings, where environmental awareness increases the probability of entering environmental schemes (e.g. DeSouza Filho *et al*, 1999; Lynne *et al*, 1988). The coefficient of risk attitude (risk) has the expected effect as well; with risk averse farmers being less likely to adopt. Risk attitude is seen as an important factor in technology adoption (e.g. Feder *et al*, 1985) and research results show that organic farmers are less risk averse than their conventional counterparts (e.g., Lien *et al*, 2003; Serra *et al*, 2007). Profit orientation (profit) was found not to be significant. According to Lynne *et al* (1988) farmers who express high profit orientation are less likely to take up environmental practices, but due to the expected higher output prices in organic farming, this decision is expected to be more profit motivated. Although organic farming is regarded as information intensive (Padel, 2001); information gathering behaviour (inf) was found not to be significant. The variable accounting for social influence (sn) does not show a significant influence either. In the current literature it is widely agreed that farmers' decisions are dependent on others (e.g. Rehman *et al*, 2007) and DeFrancesco *et al* (2008) showed an impact of neighbouring farmers on participation in environmental measures.

The exit model

The results from the estimated Cox-Model are presented in Table 4. Model 1 contains all explanatory variables, whereas Model 2 includes only significant variables. Just as in the entry model, coefficients are reported as hazard ratios ($\exp(\beta_i)$). A value greater than one means a positive effect on the exit, which also means a negative effect on staying organic; a value of less than one has a negative effect on the exit from organic farming and a value of one equals no impact.

Table 4: Estimates of Cox-Model hazard functions

	Model 1 Hazard ratio	Model 2 Hazard ratio
province	n.s.	
uaa	1.01 (0.701)	
lutotal	1.02 (0.375)	
luh	0.09 (0.021)**	0.33 (0.033)**
labour	0.24 (0.008)**	0.21 (0.001)**
ofw1	2.49 (0.042)**	2.30 (0.024)**
hhmemb	1.05 (0.697)	
farmex	1.01 (0.513)	
sex1	1.16 (0.793)	
ed	n.s.	
future2	0.53 (0.459)	
future3	0.16 (0.026)**	
future4	0.30 (0.200)	
future5	0.65 (0.691)	
future6	0.14 (0.036)**	
infnumbd2	0.37 (0.081)*	0.56 (0.191)
innumbd3	0.12 (0.000)**	0.25 (0.000)**
ifad	2.50 (0.110)	3.83 (0.005)**
iofd	1.05 (0.923)	
iotherd	1.43 (0.509)	
irepsd	0.96 (0.926)	
iocbd	0.76 (0.644)	
ipd	0.36 (0.076)*	
membn	n.s.	
knowof1	0.40 (0.093)*	
env	1.67 (0.057)	
profit	1.22 (0.401)	
risk	0.83 (0.308)	
inf	1.35 (0.248)	
sn	0.87 (0.408)	
Log likelihood	-154.73	-167.24

Values in brackets are p-values; where one equals no impact; *P<0.1; **P<0.05.
No values are reported for dummy variables that are not significant in Model 1.

In the exit model dummy variables (province) for the four provinces in Ireland were included, to account for regional differences, but they do not show a significant effect. This was expected to be an important factor as it accounts for access to organic markets. Lack of market outlets was stated as one of the main reasons to drop out of organic farming. A possible explanation could be that due to the small group of ex-organic farmers it was not possible to measure the regional influences at a greater degree of regional disaggregation, such as county level.

Looking at the structural variables, farm size (uaa, lutotal) does not show an impact on exit from organic farming. The expected effect of farm size was negative, as larger farms have a comparative advantage due to economics of scale. Previous research results on abandonment of technologies are inconclusive; for instance Walton *et al* (2008) expected a negative effect of farm size on the disadoption of soil sampling methods, but found it to be positive and An (2008) found no effect of the number of cows on the disadoption of recombinant bovine somatotropin in the U.S. dairy industry. Labour units on the farm (labour) and livestock density (luh), show the expected negative impact on the hazard. Organic farming is in general assumed to be more labour intensive (e.g. Hattam and Holloway, 2007); especially at the beginning when the farmer has to adjust to the new farming techniques and establish new markets. Therefore it is not surprising that higher total labour units and livestock density have a negative effect on the hazard to exit. This finding is confirmed by the significant influence of off-farm job (ofw1). If the main farm holder has an off-farm job has a strong positive impact on the hazard to exit. These farmers have limited time to spend on their farm and therefore it is assumed to be more difficult to adjust to the new system and meet the organic regulations. Problems with the organic regulations and certification process were frequently mentioned as a reason to abandon organic farming.

None of the farmer and household characteristics (hhmemb, farmex, sex1, future, ed) have an impact on the probability to exit. Number of household members (hhmemb) was expected to negatively impact the exit. In general number of household members serves as a proxy for available family labour and increasing household size may limit the freedom in farm decision making (Battershill and Gilg, 1997). Due to better knowledge about the environment in which decisions are made (Genius *et al*, 2006), farming experience (farmex) was expected to have a negative impact on the hazard to exit. Rigby *et al* (2001) found female farmers as more likely to drop out of organic farming. A result that could not be confirmed in this study, as gender (sex1) is not significant on the probability to abandon organic farming. The variable future is significant in Model 1, but turns out to be not significant in Model 2. However, this indicates an influence of succession and further planning on the farm, which is seen as important on

farm decisions in the literature (e.g. DeFrancesco *et al*, 2008; Walton *et al*, 2008). In line with the finding by Carletto *et al* (1999) education (ed) was found not significant on the hazard to exit, but education is regarded to be more important on the adoption decision.

Looking at the variables that represent the impact of information; number of different information sources used (infnumb) show a negative significant impact on the hazard to exit. As expected, farmers who use more different information sources have a lower hazard to exit than farmers who use just one or no information source at all. Difficulties in interpreting information and converting into a useful management plan are cited as a reason to abandon a technology (Griffin and Lambert, 2005); therefore using more information sources, helps the ease of adjustment to the new system.

In terms of the influences on adoption, if the farmer was influenced by a farm advisor (ifad) is the only significant influence in Model 2. The hazard to drop out is higher, if the farmer's decision to adopt organic farming was influenced by a farm advisor. Although the impact was initially expected to be positive, considering the negative influence of farm advisors on adoption, this finding is less surprising. Walton *et al* (2008) hypothesized extension service to be negatively correlated with abandonment of soil precision sampling, but did not find it to be significant. They argue that if extension services were better able to provide farmers with useful information this could reduce withdrawal.

Turning to social influence on abandonment, number of memberships (membn), which was expected to negatively effect exit decisions, was not found to be significant. Knowing another organic farmer (knowof1) has the expected negative influence on the hazard to exit in Model 1, but is not significant in Model 2.

None of the attitudinal variables shows a significant effect on the hazard in Model 2. Environmental attitude (env) has a positive significant influence on exit, at the 10% level. This is an interesting result, as it would be expected that a high environmental concern has a negative impact on abandonment of organic farming. However, some farmers drop out due to personal disappointment with the development of organic farming, which may explain the direction of this influence. Profit motivation does not show a significant impact, though the positive sign is as expected. Rigby *et al* (2001) found an increasing likelihood of reversion from organic farming of farmers who converted due to mainly economic reasons. Information seeking behaviour was expected to negatively influence exit decisions, as a farmer who has better knowledge about organic farming is less likely to make a wrong decision but was found not to be significant.

Conclusion and further work

Considering the fact that the Irish organic sector is underdeveloped in comparison to other European countries, exploring the reasons why farmers enter or exit the organic sector is of particular interest. This study uses a duration analysis approach to model both, adoption and possible abandonment of organic farming in Ireland.

Duration analysis has a clear advantage in comparison to bivariate models as it is possible to include time effects. Time plays an important role in explaining adoption and possible abandonment, as it captures important processes such as policy changes, development of input and output prices, learning-by-doing or learning from others. The implementation of REPS which included support payments for organic farming in 1994 was found to be an important driving factor for organic farming. Input and output prices, which were shown to be important in other studies (e.g. Pietola and Lansink, 2001) were not available at the time of data analysis, but are planned to be included in future work. Furthermore more recent policy changes (decoupling, organic farming scheme) are not incorporated in the analysis yet, although entry dates into organic farming in the sample suggest an influence. The interesting finding of the negative effect of (conventional) farm advisors on the development of organic farming indicates a lack of available information for organic farming in Ireland. Furthermore, it underlines the importance of information services on the development of organic farming, which was also confirmed by several other studies (e.g. Genius *et al*, 2006; Lohr and Salomonsson, 2000). Whether the recent increase in the provision of organic information in Ireland cannot yet be observed in the data, or if the available information is still limited, remains unclear.

The results also suggest that the attitudes of the farmer have an important effect on the decision to adopt. High environmental concern was identified as a driving factor, whereas more risk averse farmers were found to be more reluctant to adopt. These results have to be interpreted with caution and the typical question emerges: Is the behaviour caused due to the attitudes or are the attitudes developed through performing the behaviour? Due to cross-section survey data on which most adoption studies rely, this question is hard to answer. However, in this study, organic and ex-organic farmers show very similar attitudes, whereas conventional farmers clearly differ in their attitudinal scores. This indicates that conventional and organic farmers generally differ in their attitudes and assuming an influence on adoption decisions seems reasonable. Interestingly, none of the attitudinal variables have an impact on exit decisions. But following the literature it is widely agreed that attitudes of the farmer have an important impact on the adoption of environmental practices, whereas the traditional technology

adoption literature assumes that the farmer adopts a technology based on the expected profits from that technology (e.g. Walton *et al*, 2008). The results of this study confirm this assumption as abandonment is mainly driven by economic and structural considerations.

An important conclusion drawn from this research is that farmers who work full-time on the farm and manage a more 'intensive' farm system are less likely to leave organic farming again. Furthermore, subsidies are identified as an important driving factor. According to Lohr and Salomonsson (2000) access to more market outlets and information sources rather than subsidies may be used to encourage organic agriculture. This indicates that the importance of organic subsidies could be accelerated due to a lack of organic markets and available information on organic farming in Ireland. However, it underlines the importance of a changing (economic) environment and information provision on the development of organic farming. Since this research is still in progress, it appears that a closer investigation of these factors is worth further research.

References:

- An, H. (2008) *The Adoption and Disadoption of Recombinant Bovine Somatotropin in the U.S. Dairy Industry*; Conference paper presented at the American Agricultural Economics Association Annual Meeting, Orlando.
- Battershill, M. and Gilg, A. (1997) *Socio-economic Constraints and Environmentally Friendly Farming in the Southwest of England*; *Journal of Rural Studies* 13, 213-228.
- Blossfeld, H.-P., Golsch, K. and Rohwer, G. (2007) *Event History Analysis with Stata*; Lawrence Erlbaum Associates, London.
- Burton, M., Rigby, D., Young, T. (2003) *Modelling the adoption of organic horticultural technology in the UK using Duration Analysis*; *The Australian Journal of Agricultural and Resource Economics* 47 (1), 29-54.
- Cameron, C. and Trivedi, P. (2005) *Microeconometrics, Methods and Applications*; Cambridge University Press.
- Carletto, C., de Janvry, A. and Sadoulet, E. (1999) Sustainability in the Diffusion of Innovations: Smallholder Nontraditional Agro-Exports in Guatemala; *Economic Development and Cultural Change* 47(1), 345-369.
- DeFrancesco, E., Gatto, P., Runge, F. and Trestini, S. (2008) *Factors Affecting Farmers' Participation in Agri-environmental Measures: A Northern Italian Perspective*; *Journal of Agricultural Economics* 59(1), 114-131.
- Department of Agriculture, Fisheries and Food (2002) *Census of Irish Organic Production 2002*.
- DeSouza Filho, H., Young, T. and Burton, M. (1999) *Factors Influencing the Adoption of Sustainable Agricultural Technologies, Evidence from the State of Espirito Santo, Brazil*; *Technological Forecasting and Social Change* 60, 97-112.
- Ellison, G. and Fudenberg, D. (1993) *Rules of Thumb for Social Learning*; *Journal of Political Economy* 101(4), 612-643.
- Feder, G., Just, R.E. and Zilberman, D. (1985) *Adoption of Agricultural Innovations in Developing Countries: A Survey*; *Economic Development and Cultural Change* 33 (2), 255-298.

Genius, M., Pantzios, C., Tzouvelekas, V. (2006) *Information Acquisition and Adoption of Organic Farming Practices*, Journal of Agricultural and Resource Economics 31(1),93-113.

Greene, W. (2003) *Econometric Analysis*; Fifth Edition; Pearson Education, New York.

Griffin, T.W. and Lambert, D.M. (2005) *Teaching Interpretation of Yield Monitor Data Analysis: Lessons learned from Purdues's Top Farmer Crop Workshop*; Journal of Extension 43(3), 1-4.

Hattam, C. and Holloway, G. (2007) *Bayes Estimate of Time to Organic Certification*; Conference paper presented at the Agricultural Economics Society's 81st Annual Conference, University of Reading, UK.

Jenkins, S.P. (2004) *Survival Analysis*; lecture notes.

<http://www.iser.essex.ac.uk/teaching/degree/stephenj/ec968>

Kalbfleisch, J. and Prentice, R. (2002) *The Statistical Analysis of Failure Time Data*; Second Edition, Wiley-Interscience, New Jersey.

Lambert, D.M., Sullivan, P., Claassen, R. and Foreman, L. (2007) Profiles of U.S. Farm Households Adopting Conservation-Compatible Practices; Land Use Policy 24, 72-88.

Lien, G., Flaten, O., Ebbesvik, M. Koesling, M. and Steinar Valle, P. (2003) *Risk and Risk Management in Organic and Conventional Dairy Framing: Empirical results from Norway*; International Farm Management Congress.

Lohr, L. and Salomonsson, L. (2000) *Conversion Subsidies for Organic Production: Results from Sweden and Lessons for the United States*, Agricultural Economics 22, 133-146.

Lynne, G., Shonkwiler, J., Rola, L. (1988) *Attitudes and Farmer Conservation Behavior*; American Journal of Agricultural Economics 70 (1), 12 -19.

Marra, M., Pannell, D. and Abadi Gadhimi, A. (2003) *The economics of risk, uncertainty and learning in the adoption of new technologies: where are we on the learning curve?* Agricultural Systems 75 (2-3), 215-234.

Moran, B. and Connolly, L. (2007) *Economics of Organic Farming*; Conference paper presented at the National Organic Food Conference, Tullamore.

Padel, S. (2001) *Conversion to Organic Farming: A typical example of the diffusion of an innovation?* Sociologia Ruralis 41, 40-61.

Padel, S. and Lampkin, N. (1994) *The Economics of Organic Farming, An International Perspective*, CAB International.

Pietola, K.S., and Oude Lansink, A. (2001) *Farmer response to Policies Promoting Organic Farming Technologies in Finland*, European Review Agricultural Economics 28, 1-15.

Rehman, T., McKemey, K., Yates, C.M., Cooke, R.J., Garforth, C.J., Tranter, R.B., Park, J.R., and Dorward, P.T. (2007) *Identifying and understanding factors influencing the uptake of new technologies on dairy farms in SW England using the theory of reasoned action*, Agricultural Systems 94 (2), 281-293.

Rigby, D., Young, T. and Burton, M. (2001) *The development of and prospects for organic farming in the UK*; Food Policy 26, 599-613.

Serra, T., Zilberman, D. and Gil, J. (2007) *Differential Uncertainties and Risk Attitudes between Conventional and Organic Producers: The Case of Spanish Cop Farmers*; Conference Paper presented at the American Agricultural Economics Association.

Walton, J., Lambert, D., Roberts, K., Larson, J.A., English, B., Larkin, S., Martin, S., Marra, M., Paxton, K., and Reeves, J. (2008) *Adoption and Abandonment of Precision Soil Sampling in Cotton Production*; Journal of Agriculture and Resource Economics 33(3), 428 – 448.

Wilson, G.A. (1996) *Farmer environmental attitudes and ESA participation*, Geoforum 27, 115-131.

Wynn, G., Crabtree, B. and Potts, J. (2001) *Modelling Farmer Entry into the Environmentally Sensitive Area Schemes in Scotland*, Journal of Agricultural Economics 52, 65-82.