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# To leave or not to leave? Understanding determinants of farmers' choices to remain in or abandon agri-environmental schemes

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ABSTRACT

Effectiveness of Agri-Environmental Schemes (AESs) as tools to enhance the rural environment can be achieved not only by increasing uptake rates, but also by avoiding participating farmers abandoning the scheme once they are in. For this reason, it is important to also consider what affects farmers' decisions to remain in the scheme rather than leave it at the end of the contractual obligation. However, up to now, there has been very little on this issue in the literature. The paper offers a contribution to this by revealing the role of determinants like the farmer's and farm structural characteristics, farmer's learning process, neighbourhood effect and the impact of changes in the policy design on the farmer's decision to remain in the scheme over a long time scale. This is examined in a long-standing scheme in the case study area, the Veneto Region of Italy. The paper uses duration analysis and is based on longitudinal panel-data of the entire population of 2000–2015 adopters. By using only data available in official regional records, it also provides regional policy-makers with an operational tool that is useful to analyse the impact of their AES design changes. The results of the duration models show that a larger farm size, a younger farmer age, the succession in the family farm, and the farmer's positive attitude towards the environment, trigger longer durations in AES. Similarly, the impact of the accumulation of the farmer's experience in the scheme management, as well as the neighbourhood effect increase the probability of remaining. Lastly, the changes in policy tailoring and targeting also have a positive impact on maintaining the farmer in the scheme. The paper concludes by noting that duration analysis can deliver useful results in order to guide policy-makers in the effort to steer higher levels of farmers' persistence in the scheme and provides some recommendations for a more mature agro-environmental policy design.

## 1. Introduction

Over the last four decades, the importance of EU Agri-Environmental Schemes (AESs) as voluntary tools aimed to enhance the rural environment beyond legal requirements has greatly increased, in terms of both expenditure and participation (Riley, 2016). After a few voluntary initiatives by individual countries in the 1980s (Ducos et al., 2009), AESs gained momentum with the introduction of the first EU-wide Regulation 2078/92; since then, AESs have regularly been proposed to farmers in three consecutive EU Rural Development rounds. Prompted by the need to improve policy outcomes, research in the field of AES adoption has grown in parallel (Wilson and Hart, 2001) and a large body of literature now provides scientific evidence of the role of farm structural factors, farmers' characteristics, motivations and attitudes, and institutional elements as determinants of participation (see Mettepenningen et al., 2013; Reimer et al., 2014; Lastra-Bravo et al., 2015 for updated reviews).

In recent times, stimulated by a growing availability of participation data and emerging concern about AESs' effectiveness in the long-term, there has been a debate on the temporal dynamics of participation (Ingram et al., 2013). It has been argued that AESs sometimes need a long period to produce the desired environmental benefits, often beyond the ordinary contract duration (Swetnam et al., 2004). In addition, they may require relevant changes to farming practices, resulting in more complex and lengthy decision-making patterns (Gamon and Scofield, 1998; Jackson-Smith et al., 2010; Karali et al., 2014, Pedzisa et al., 2015). Once accomplished, adoption should hence be accompanied by steady behavioural changes (Reimer et al., 2014), while early withdrawals from the schemes may jeopardize or even nullify the AESs' long-term success (Wilson and Hart, 2001; Burton and Paragahawewa, 2011; Riley, 2016).

These arguments point out that there is a need to better understand the determinants of farmers' choices over a longer time scale than that of a single contract; they also indicate that looking at AES from a single

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perspective that considers only adoption determinants would not fully capture the impact of the policy design, hindering any understanding of the reasons why a farmer would decide to remain in the scheme, signing a new contract, or leave it when the opting-out opportunity is available at the end of the contract. Attentively considering the patterns of the decision to remain in a medium-long-term perspective would feed a policy design better oriented towards persistent sustainable environmental change (Morris, 2004).

Yet, given the recent attention to AESs' time dynamics, and a persisting scarcity of longitudinal data at farm level (Moser and Barrett, 2006, Kallas et al., 2010), the research on farmers' choices regarding continuation or disadoption of AESs over long time periods is in an early stage and still poorly represented in the literature (Riley, 2016).

This paper aims to contribute to the nascent AESs' duration research by considering the role played by the time dimension on the farmers' decision process when he/she faces the option of remaining in the scheme by subscribing a contract again. More specifically, it intends to reveal the effects – over the 'remaining or leaving' option – of determinants such as some static farmer's and farm structural characteristics as well as time-varying aspects affecting the innovation diffusion patterns like the farmer's learning process linked to the duration and neighbourhood effect. The paper also addresses the effects of changes in the policy design, which have up to now been scarcely explored even in the adoption literature (Raggi et al., 2015).

We chose as case study the AES with the longest history in the agri-environmental policy of the Veneto Region[1], Italy: a scheme aimed at supporting planting and/or maintaining hedgerows and buffer strips on farmland; with some policy design changes, the scheme has been ongoing in Veneto without interruption since the early 1990s. Analysing such AES gave us the opportunity not only to explore the effect of time on farmers' decisions in a long time perspective, but also to contribute to fill a gap in the literature as, to our knowledge, adoption and disadoption of schemes focused on planting and/or maintaining landscape and habitat elements as hedgerows or buffer strips have been scarcely explored so far.

Additionally, our work provides regional policy-makers with a relatively ready-to-implement tool, useful to analyse the impact of their AES design changes on the decisions of farmers to remain or leave, and to further improve the schemes accordingly. This is possible because only data obtained from official regional records on AES contracts have been used. As this information on participating farms is already possessed by the public authorities, no *ad hoc* costly and time-consuming sample-based data collection is required to perform the analysis.

The study is based on a longitudinal panel dataset of the entire regional population of adopters, i.e. those who have been in the AES for at least one contract period over a time span of sixteen years (2000–2015).

## 2. Related literature

Initial contributions to studying how AES adoption rates have evolved over time come from the agricultural innovation diffusion literature, which has cast light on the factors affecting the entry decision by early, medium and late adopters. Examples include studies of diffusion of organic agriculture (Padel, 2001; Läpple and Van Rensburg, 2011), as well as best management (Brown et al., 2016) and soil conservation practices (Varble et al., 2016). The joint effect of time, space and social capital variables has also been tackled by several studies, showing the effect of physical neighbourhood (Lewis et al., 2011; Chen et al., 2012), peer-to-peer learning (Woolcock and Narayan, 2000) and networks (Berger, 2001; Klerkx and Leeuwis, 2009; Moschitz et al., 2015; Taylor and Van Grieken, 2015) on adoption rates of different agricultural practices.

[1] The term 'region' is used here with a legal-administrative meaning, rather than a broad geographical one. The regional government in Italy has legal-political jurisdiction over the design of the Rural Development Programmes, hence over AESs.

A series of researches address the issue of why farmers adopt or abandon a certain farming practice in different periods in relation to external changes. Marenya and Barrett (2007), for example, showed how financial factors, technological progress and perception of risk, delay the speed at which Kenyan farmers adopt or abandon soil fertility management practices, while Nyblom et al. (2003) highlighted the role of information in decreasing uncertainty when adopting innovation in Finland. Yet, the literature on the determinants of the remaining or leaving option over time seems hitherto to have mostly concentrated on a broad international focus, with researches addressing cover crops in northern Honduras (Neill and Lee, 2001), agricultural system shifts in western Nigeria (Kolawole et al., 2003), lower-input rice technology adoption and disadoption in Madagascar (Moser and Barrett, 2003), sustainable agricultural technologies in Brazil (De Souza Filho et al., 1999), introduction of technological inputs in Ethiopia (Dadi et al., 2004), no-tillage practices in Australia (D'Emden et al., 2006), or land use changes connected to deforestation in tropical America (Vance and Geoghegan, 2002), while it is still fragmented when it comes to Europe and AESs. Here, published research appears mostly concerned with organic production, specifically horticulture in the UK (Burton et al., 2003), vineyards in Spain (Kallas et al., 2010) and drystock in Ireland (Läpple, 2010). Rural Environment Protection Schemes (REPS) were studied by Hynes and Garvey (2009) and by Murphy et al. (2014), who explored how Irish farmers respond over time to improved scheme design. To our knowledge, very little is available specifically on landscape and habitat features such as hedgerows or buffer strips.

From a methodological perspective, most of the cited studies on adoption, continuation and disadoption dynamics (Marenya and Barrett, 2007; Neill and Lee, 2001; Kolawole et al., 2003; Moser and Barrett, 2003; Murphy et al., 2014) have relied on cross-sectional data and static models. For this reason, they fail to provide information on the temporal dynamics of the diffusion-abandon patterns among farmers (Moser and Barrett, 2006). Authors are generally conscious that the dynamics of innovation adoption 'rather than being an event, is best seen as a process, shaped by a multitude of changing factors and endowments' (Shields et al., 1993). However, the lack of adequate panel-data and the complexity of reconstructing the dataset from official archives at farm level (Marra et al., 2003) or through retrospective sample-based surveys recreating the participation history (Moser and Barrett, 2006), limit the diffusion of analyses specifically focused on the temporal dynamics of farmer participation (Ingram et al., 2013).

Nonetheless, a few papers have recently highlighted the crucial contribution that duration analysis, long used in biomedical, engineering and social research, can offer. Being based on longitudinal panel-data, duration analysis is a powerful tool for exploring temporal adoption dynamics: thanks to the simultaneous use of cross-sectional and time-varying data, duration analysis allows continuation or disadoption choices to be fully explored from a dynamic perspective, as well as to consider the impact of external variables, for example changes in policy design, and to link them to the moment in which the decision to leave or remain is taken (Läpple, 2010). However, because of the high complexity of data required, there have been few applications of duration analysis so far in agricultural economics, which include the already quoted works by De Souza Filho et al. (1999), Dadi et al. (2004), D'Emden et al. (2006), Hynes and Garvey (2009), Moser and Barrett (2006), Burton et al. (2003), Kallas et al. (2010), and Läpple (2010).

## 3. Case study and policy context

More than half of Veneto, a region in the north-east of Italy, consists of the Po Valley, a large, fertile, intensively farmed area. This vast flat territory has a long colonisation history with many changes to its landscape over time. Until the first third of the 20th century, the typical Veneto Po Valley landscape was formed by farming plots completely surrounded by rows of trees. In the last eighty years, with the expansion of urbanisation, industrialisation and farm mechanisation, the green edges of farmed fields almost completely disappeared, making way for wider fields with no or very few hedgerows (Tempesta, 2010). The remnants of the old forests were cleared and replaced by urban sprawl (Vaz and Nijkamp, 2015). During the 1980s, eutrophication of the Venice lagoon due to high nutrient loads from the intensively-farmed area of the watershed, emerged as an urgent problem (Collavini et al., 2005), inducing the regional authorities to designate the Venice lagoon drainage basin as a priority target area for regulating non-point pollution (Marcomini, 2005).

When the regional authorities began to implement the EU agri-environmental policies in this scenario, attention was paid to improving landscape and ecological connectivity and mitigating the effects of the high nutrient loads in surface and ground waters in the intensively farmed areas. To this end, planting and maintaining hedgerows and (later) buffer strips was one of the earliest measures adopted. In order to reach the highest effectiveness, and considering that farmers looked at hedgerows and buffer strips as a burden for mechanisation of their farms and a receptacle of pests (INEA, 1999), a series of voluntary schemes has been offered to farmers since the early 1990s. Regional initiatives – Regional Law no. 42/1997 (Regione Veneto, 1997) and *Piano Direttore 2000* for Venice drainage basin (Regione Veneto, 2000) – followed the EU programmes and mimicked their design, providing additional funds to increase farmers' participation in specific target areas.

Before the turn of the millennium, EEC Regulation 2078/92 and the connected regional schemes granted five-year contracts and aid only for pro-actively maintaining existing hedgerows. The whole regional farming area was eligible for participation. The policy was designed according to a geographical criterion that assigned the highest payment tier to farms in flat areas and environmentally-sensitive zones (parks and Venice lagoon drainage basin), medium to farms in hilly areas, and the lowest to farms in mountain areas (Table 1). A minimum of 5% and maximum of 10% of the Utilized Agricultural Area (UAA) was allowed per farm under the scheme, the latter to avoid excessive extensification. Initially, the scheme struggled to take off, but applications later grew and doubled in number in 1997, finally registering an overall uptake of 857 ha on 1876 farms, mostly in the lowlands (INEA, 1999).

In the new millennium, the policy design changed radically after the inclusion of AESs within the framework of the Rural Development Programmes (RDPs). In terms of targeting, farms in mountain areas were no longer eligible, while geographically-differentiated payment tiers were replaced by a system of area-based scores, assigning the highest priority scores to farms located in environmentally-sensitive target areas (Fig. 1). Regarding adoption of multiple measures, while in Regulation 2078/92 higher premiums were offered to farmers combining integrated pest management and organic agriculture with hedgerows, in the 2000–2006 RDP these were no more offered. Only few extra ranking points (2/19) were given to farmers who combined participation to more than one AES in the same farm. In the most recent RDPs, i.e. 2007–2014 and the current one, this type of incentive was cancelled. In any case, participation to multiple measures did not occurred very often in the region: for example, in the period 2000–2006, hedgerows were combined with integrated agriculture only in 6,4% of cases and with organic agriculture only in 3,2%.

Tailoring efforts were also made to align the policy design to the situation on the ground, to increase the attractiveness of the scheme to farmers:

– besides maintaining existing hedgerows, support was extended to include the planting of new hedgerows or buffer strips
– a requirement for an additional grass strip to be kept free of cultivation, so to reduce the disturbance on the hedgerow or buffer strip habitat, was introduced. This area was compensated with a payment and facilitated also the mechanical crop management by the farmer. The minimum required width of this grass strip was gradually increased over time
– the upper threshold of farm UAA under contract was increased to 20% for buffer strips, while it remained at 10% for hedgerows
– the pre-existing minimum of 5% of UAA, discouraging participation, was replaced by 0.25 ha until 2008, then reduced to 0.125 ha in 2009.

Payments were also simplified and reshaped (Table 1). The most important changes introduced since 2007 have been:

– all costs incurred by farmers participating in the scheme were refunded, based on an average estimate of planting and management costs, of gross-margin lost due to the UAA reduction and of transaction costs
– a progressive increase of payments was introduced in order to take into account i) the impact on opportunity costs of participating connected to the CAP first-pillar area payments gradual decoupling and the dynamics of crop prices and ii) the higher average costs (with respect to the cost estimates used in the RDP 2000–2006) incurred by smaller farms when compared to larger farms
– the payments schedule was better matched to farmers' expenditure-flows over time by passing from a flat average payment over five years to a differentiated payment for planting (*una tantum*) followed by five years for maintenance
– a simplification of both payment structure and its management was introduced, as the payments for the grass strip area − initially managed independently − were unified with the connected hedgerow or buffer strip area
– an incentive to remain in the AES was set up, through an annual payment given to farmers who subscribe a renewal contract higher than that given to new AES adopters.

**Table 1**
Payments granted for hedgerow and buffer strip planting and maintenance under different AES policy designs in the Veneto Region 1994–2015.

| | Payments − € per m² per year | | | | |
|---|---|---|---|---|---|
| | (a) Maintaining existing hedgerows | (b) Planting new hedgerows or buffer strips | (c) Maintaining hedgerows or buffer strips | (d) Maintaining hedgerows or buffer strips from participation in previous AESs | (e) Grass strip |
| Before 2000 | 0.10 – 0.20[b] | | | | |
| 2000–2006 | | 1.50[c] | 0.50 | 0.50 | 0.13 |
| 2007–2014 | | 5.45 until 2010 | 0.80 until 2010 | 1.29 until 2010 | included in (c) or (d) |
| | | 7.57 from 2011 | 1.16 from 2011 | 1.71 from 2011 | |
| 2015–2020[a] | | 8.37 | 2.42[d] | 2.42[d] | included in (c) or (d) |

[a] At the time of our analysis only one (d)-type call has been published by regional authorities.
[b] According to geographical location.
[c] 5-years flat average payment per year, including planting and maintenance costs.
[d] Valid only if the farmer does not fulfil Ecological Focus Areas (EFA) commitments through hedgerows and buffer strips, otherwise payments are substantially lower.

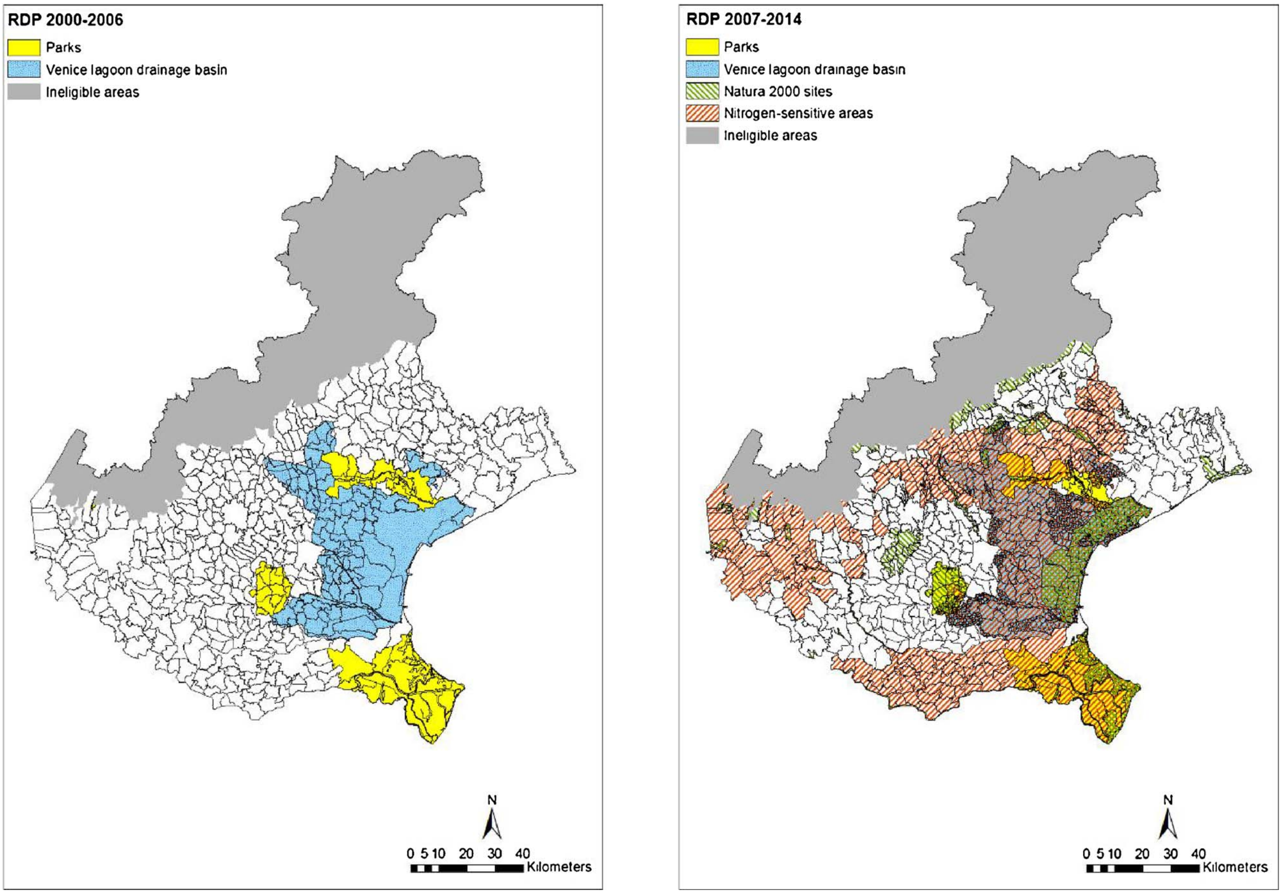


**Fig. 1.** Target areas for RDP 2000–2006 and RDP 2007–2014 (the target areas do not change in RDP 2015–2020).

In return for payments, farmers who subscribed a contract had to actively maintain the functionality of the hedgerows or buffer strips by committing to various maintenance operations including pruning, keeping crown density, controlling undesirable species, replacing dead trees with native species only, and maintaining the grass strip in order to keep the ecological functionality of such complex ecosystems (Sitzia et al., 2013).

The efforts to stimulate participation, and especially to include small farmers, resulted in a successful increase of both area under contract and number of participants: cross-section data of uptake report 1,500 ha on 2026 farms in 2005 (Agriconsulting, 2008), 2,944 ha on 3051 farms in 2012 (Agriconsulting, 2012) and 3,168 ha on 3992 farms in 2015. 98% of the area under contract is localised in the lowlands, where pre-existing hedgerows had almost completely disappeared as a consequence of diffusion of intensive and highly-specialised agricultural systems (Agriconsulting, 2008).

## 4. Model and data

When the AES contract expires at the end of its duration, a farmer has the option of remaining in the scheme by subscribing a renewal contract, or to leave it. Our focus is on this decision, i.e. we want to model the remaining behaviour of a farmer who already was in the AES, while we are not interested in the adoption behaviour of new participants in the scheme. Normally, farmers face this choice every five years, at the end of the regular contract duration; however, longer durations are also observed, when the regional authorities give the opportunity to farmers to extend contracts until the end of the RDP programming period. The contract conditions may remain the same or become more favourable as pointed out in the previous section. The 'remaining' behaviour can be modelled under a duration analysis approach.

Given this focus, our risk set – the 'population at risk' – is made by all farmers who are under an AES contract in the analysed period (2000–2015) at least for a given spell. This implies that, differently than the consuetudinary duration analysis approach, where the focus is on the event-occurrence – that, in our case, would be represented by not renewing the contract – we modelled the opposite perspective, i.e. the non-occurrence, that is the 'remaining' option.

In bio-medical, engineering and social science research, where it has been widely used for decades, duration analysis is usually referred to as survival analysis (Vance and Geoghegan, 2002). Thanks to pioneering work by Lancaster (1979), the method was later introduced in the economic literature and used first to address unemployment duration. The literature proposes a wide range of duration models, ranging from continuous-time parametric (e.g. exponential, Weibull, lognormal, log-logistic distributions) and semi-parametric (e.g. Cox regression) models to discrete-time hazard models (Singer and Willett, 2003). The choice of a continuous or a discrete-time approach largely depends on the continuous or discrete survival time of the process being analysed (DeMaris, 2004; Allison, 2014).

We adopted a discrete-time duration model, dropping the continuous-time approaches for two main reasons: i) the time at which a farmer is first exposed to the risk, i.e. he/she signs an AES contract, is intrinsically discrete, as calls for contract subscription are not issued every year in a given RDP, but depend on policy-makers decisions[2]; ii) even more importantly, the decision to leave shows relevant 'ties' to the duration, as this option is most frequently taken after the five-year regular contract duration (or multiples of it); longer duration ties are

[2] The Veneto Region issued two calls at the beginning of the period for RDP 2000–2006, yearly calls for RDP 2007–2014, and – up to the time of our analysis – one call in 2015 for RDP 2015–2020.

also observed. When there are several tied-duration times in the data, as in our case, the continuous-time approach becomes unreliable (Cox and Oakes, 1984; Yamaguchi, 1991).

We created a yearly farm-level panel dataset of the entire population of AES participants over a time span of sixteen years by linking together the cross-section official datasets of every AES call during the period. When tracking the Land Register unit code of the land units under contract, two different cases occurred: i) in most cases, the land units did not undergo an ownership change: in this case, the records referring to the same farm over time were joint by means of the farm's fiscal code; ii) conversely, in some other situations, there was a change of ownership or tenure; in these cases, we considered the contract as continuing by a new farmer and not as a new entry. In other words, we followed the history of the land unit remaining or leaving in the AES also in case of change of ownership of the land unit itself. Overall, 5311 farms (4.7% of farms in the eligible areas of the Veneto Region according to the 2010 Census) were under AES contract in the study period, at least for a limited spell; no repeated events were observed – i.e. farmers leaving the AES at a given time in the study period and signing a new contract later.

A crucial aspect to be considered in duration analysis is the censoring problem (Allison, 2014). In our dataset, only right-censoring occurs when a farmer never abandoned the contract during the analysis period; consequently, censored data are observed only in 2015, when a farmer renewed the contract under the first RDP 2015–2020 call. The issue of left-truncation – i.e. the farmer's entry in the risk set prior to the start of the study period – was easily addressed as our dataset reported the farmer's time of first signing under the pre-existing schemes (Reg. 2078/92 or regional initiatives, 4% of farmers in the panel dataset): the number of years under ante-2000 contracts have been incorporated into the individual farmer's AES duration at each time *t* (Singer and Willett, 2003).

Under the discrete approach, the farm-based panel dataset has to be restructured into a farm-year dataset, i.e. a dataset where a separate observational record is created for each year *t* in which the $i^{th}$ farmer is at risk of remaining or leaving the AES (Singer and Willett, 2003). However, the first five-year contract period is mandatory for the farmer, so it is uninformative for our research purpose, being linked to the adoption decision, not to the remain or leave one: therefore, by analogy with Moser and Barrett (2006), we dropped the first five records associated to the first contract signed by the $i^{th}$ farmer in the study period from the farm-period dataset, while the remaining or leaving information from the 6th year is retained. Accordingly, 2922 farms of the initial farm-based panel dataset led to 10745 observations in the farm-year dataset. 42,5% of farmers in the farm-based panel dataset, 11.6% in the farm-year dataset, left the AES during the study period; the median period of staying under the AES contract is 6 years, while the observed maximum is 23 years. Fig. 2 reports the Kaplan-Meier estimated survival function.

Under a discrete-time approach, the discrete time hazard $P_{it}$ defines the conditional probability that the $i^{th}$ individual faces the target event at the particular time *t,* given that no event occurred to him/her before time *t,* i.e. he/she is in the risk set at that time:

$$P_{it} = P\ (T_i = t\ |T_i \geq t)$$

where $T_i$ is a discrete time variable that denotes event occurrence for the $i^{th}$ individual. All records in the farm-year dataset are conditionally independent (Singer and Willett, 2003).

The model used most for truly discrete-time hazard is the logit model (Allison, 2014), which explains the log-odds of the event occurrence at time *t* as:

$$\ln \frac{P_{it}}{1 - P_{it}} = \alpha(t) + \mathbf{x}^{i'}\boldsymbol{\beta}$$

where *α(t)* explains how the log-odds of the event depends on time, while $x^i$ takes into account the effects of both time-invariant and time-variant predictors.

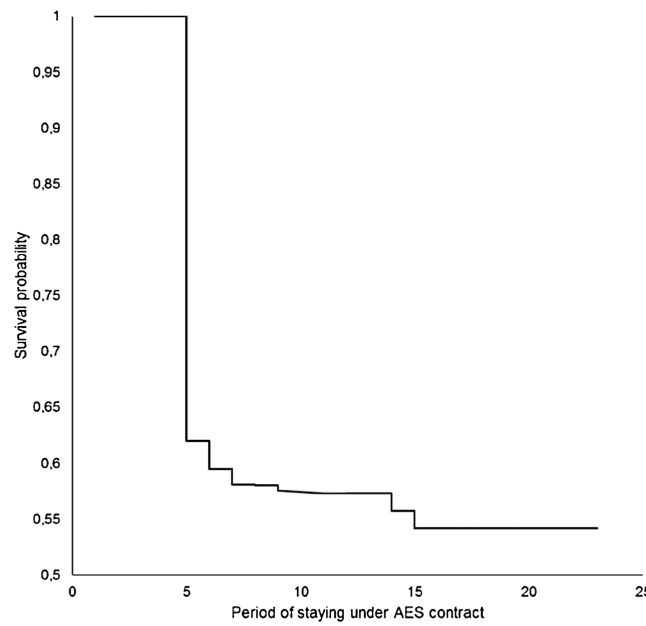


**Fig. 2.** Kaplan-Meier estimated survival function.

As we preferred to model event non-occurrence, i.e. the remaining event, rather than the leaving event, in order to more easily analyse the effect of predictors on the remaining option, the observed dichotomous variable $T_i$ defining the target event occurrence for the $i^{th}$ farmer at each time *t* was set at 1 for remaining and 0 for leaving.

Given the scarcity of duration literature, the independent variables we included in the model were selected according mostly to AES adoption literature. The latter considers that, in line with the theory of reasoned action and planned behaviour (Ajzen and Fishbein, 2005), the behavioural intentions of farmers are directly related to a wide range of background factors: individual factors, including farm and farmer's factors, social factors and informational factors (Mettepenningen et al., 2013). Amongst individual factors, the farm size usually shows a positive impact on AES adoption, with larger farms being more frequent adopters (Wilson and Hart, 2000) or remainers (Läpple, 2010; Hynes and Garvey, 2009); the farmer's age, conversely, generally negatively affects the probability of staying in the scheme (Hynes and Garvey, 2009; Kallas et al., 2010). Social factors like the neighbourhood effect, that is the imitation of neighbour farmer, have also been found playing a positive role into the decision to remain (Moser and Barrett, 2006). Amongst the informational factors, the accumulation of experience by the farmer in the specific AES, that grows with time, has a positive effect on the probability to remain (Hynes and Garvey, 2009; Moser and Barrett, 2006). Nyblom et al. (2003) and Kallas et al. (2010) have shown that fine-tuning of policy design, acting through targeting and tailoring, also affects positively the adoption choices; however, Raggi et al. (2015) have pointed out that these factors are still understudied.

In our model, *α(t)* is a linear and quadratic function of *N_Years,* a time-varying variable describing how many years (including ante-2000 programmes, i.e. Reg. 2078/92 or regional initiatives) the farmer stayed in the risk group (i.e. remained in the AES) until time *t.* In order to facilitate the interpretation of the time effect, *N_Years* was rescaled by subtracting the median of duration as centring constant (Singer and Willett, 2003). In line with referential adoption and disadoption literature (e.g. Hynes and Garvey, 2009; Moser and Barrett, 2006) the accumulation of experience by the farmer in the specific AES is explained by the 'time' variable *N_Years* and we hypothesize that the longer the duration of participation until time *t*, the greater the learning by doing by the farmer: hence the expected sign of this time-increasing effect is positive.

Despite the limited information available for each farm in the

**Table 2**
Descriptive statistics of the predictors included in the model (n = 2922 farms).

| *Variables* | | | *Statistic* | *Value* |
|---|---|---|---|---|
| Number of years under contract (*N_Years*) | | | Median | 6 |
| Farmers participating in the AES for the first time by RDP rounds | RDP 2000–2006 or ante 2000 (*Design00_06)* | | % | 63.4 |
| | RDP 2007–2014 until 2010 (*Design07_10* = 1) | | % | 29.0 |
| | RDP 2007–2014 from 2011 (*Design11_14* = 1) | | % | 7.6 |
| Farms under AES located in target areas in selected years *(Area* = 1) | | 2000 | % | 50.9 |
| | | 2006 | % | 56.0 |
| | | 2014 | % | 90.0 |
| Farm Utilised Agricultural Area (hectares) *(F_UAA)* | | | Mean[a] | 19.68 (221.16) |
| Farmers increasing the AES area in their spell (*AES_Increase)* | | Yes = 1 | % | 13.8 |
| Farmers who planted or maintained thickets (*Thickets*) | | Yes = 1 | % | 10.5 |
| Farms by type of business and farmer's age class (for sole proprietorship farms only) (*Age_Class*) | Other types of business (=1) | | % | 8.4 |
| | Sole proprietorship | ≤40 years (=2) | % | 13.7 |
| | | 41–65 years (=3) | % | 51.2 |
| | | >65 years (=4) | % | 26.7 |
| Ownership or tenure changes in the study period (*Ch_Owner*) | | Yes = 1 | % | 9.1 |
| Mean% of farms in each Municipality under AES contract (*LAG_Farms%),* selected years | | 2000 | Mean[a] | 0.08 (0.26) |
| | | 2006 | Mean[a] | 0.51 (0.81) |
| | | 2014 | Mean[a] | 2.67 (3.33) |

[a] Standard deviation in parentheses.

official regional records on AES uptake, we were able to include in the model a number of predictors which are consistent with the above-mentioned theoretical approach.

The following covariates capture the changes in AES policy design over time:

- two dummy covariates, treated as time-invariant, defining the AES policy design under which the farmer signs the first contract − *Design07_10* and *Design11_14*, where *Design00_06* is the baseline. Given the increased tailoring efforts to align the policy design to the situation on the ground and the reshaped and increased payments, we expect that AES adoption under more recent schemes positively influences the log-odds ratio
- a dichotomous variable *Area* that equals 1 if the farmer is located in the target areas when he/she signed the contract (Fig. 1) and 0 otherwise. The expected sign of this covariate is positive, given the priority scores assigned to target areas.

The background factors are:

- a time-varying variable for farm size (farm UAA in hectares) *F_UAA*
- a dummy variable *AES_Increase* that equals 1 when the farmer has increased the area under AES contract during his/her spell, and 0 otherwise
- a dummy variable *Thickets* that equals 1 if the farmer has also planted or maintained thickets in the spell, and 0 otherwise. In our model, this variable acts as a proxy for the farmer's positive attitude towards environmental protection. Indeed, the role played by farmers' personal motivations and attitudes towards environmental protection on the decision to remain in the AES cannot be explored directly, being constrained by information availability in the official regional database we used. However, other objective and measurable factors may act as proxies for positive environmental attitudes. Defrancesco et al. (2008), for example, used past environment-friendly practices adoption
- a categorical variable *Age_Class* that identifies the age class of the farmer (less than 40; 41–65; and over 65 years) at the time of signing the first AES contract in the case of sole proprietorship, while other business types are considered together[3]. The over 65 age class is the baseline
- a categorical variable *Ch_Owner* that equals 1 in case of ownership or tenure changes during the study period, 0 otherwise. Given the regional farm structure, mostly based on family farms, these changes imply that, in most cases, younger family members take over the farm management[4]
- lastly, a time-varying lagged variable *LAG_Farms%* expressing the percentage of farms under AES at time *t-1* located in the same municipality as the $i^{th}$ individual. Given the unavailability of farm geo-localisation in our dataset, we assume this variable as a proxy for the spatial neighbourhood effect on the decision to remain at each time *t*, in line with e.g. Moser and Barrett (2006). We expect that this spillover effect is positive in the specific context of our analysis, where hedgerows had nearly completely disappeared and farmers were reluctant to introduce and manage them according to the demanding scheme requirements.

Table 2 reports some descriptive statistics of the predictors included in the models.

## 5. Results and discussion

Table 3 presents the coefficient estimates and associated standard errors of the discrete-time duration models of remaining in the AES.

Model 1 includes only the predictors expressing changes of the policy design and the area-targeting focus in the study period, and the effect of time, i.e. the number of years each farmer remains in the AES: all the estimated coefficients differ significantly from zero.

Results confirm that the policy design is an important determinant of farmers' choices, as already highlighted by Nyblom et al. (2003) and Kallas et al. (2010) for organic farming adoption and by Raggi et al. (2015) for some agri-environmental measures with specific reference to the policy targeting. Our model estimates show that the growing effort of the regional administration to tailor the policy design to the situation on the ground, the adjusting of payments, as well as the financial incentive to remain in the scheme (Table 1), positively affect the remaining odds-ratio. *Ceteris paribus*, when a farmer enters the AES under the RDP *Design07_10*, his/her remaining odds-ratio is nearly seventeen-

[3] The farm fiscal code provides information on farmer's age only for the sole proprietorship type of business.

[4] This interpretation may appear strained; however it is justified by looking at the farm structure of the region, where according to 2010 Agricultural Census, 93,2% of farms are sole proprietorship family farms. In our dataset, amongst the 9.1% of farms that have changed ownership, 73% have passed from a sole proprietorship to another individual owner; among them, 89.2% passed the farm to a younger owner: in this case, the mean age decrease is 24.4 years, that is approximately a generation.

**Table 3**
Duration models estimates for AES decision to remain.

| | Model 1 | | Model 2 | |
|---|---|---|---|---|
| Variable | β (S.E.) | Odds-ratio | β (S.E.) | Odds-ratio |
| N_Years | 1.923 (0.068)*** | 6.839 | 1.833 (0.070)*** | 6.251 |
| N_Years_squared | −0.132 (0.006)*** | 0.877 | - 0.126 (0.006)*** | 0.882 |
| Design07_10 | 2.829 (0.143)*** | 16.930 | 3.208 (0.152)*** | 24.739 |
| Design11_14 | 2.500 (0.238)*** | 12.178 | 2.925 (0.247)*** | 18.643 |
| Area | 0.262 (0.080)*** | 1.300 | 0.433 (0.092)*** | 1.542 |
| F_UAA | | | 0.003 (0.001)** | 1.003 |
| AES_Increase | | | 1.432 (0.125)*** | 4.186 |
| Thickets | | | 0.683 (0.139)*** | 1.979 |
| *Age_Class: >65 years* | | | | |
| Age_Class: Other business type | | | 0.399 (0.180)** | 1.490 |
| Age_Class ≤40 years | | | 0.715 (0.135)*** | 2.045 |
| Age_Class 41–65 years | | | 0.549 (0.104)*** | 1.732 |
| Ch_Owner | | | 3.905 (0.456)*** | 49.665 |
| LAG_Farms% | | | 0.033 (0.011)*** | 1.033 |
| Constant | − 0.236 (0.064)*** | 0.790 | − 1.501 (0.126)*** | 0.223 |
| Log L | | −2183.0 | | −1877.4 |
| Cox and Snell pseudo $R^2$ | | 0.266 | | 0.307 |
| Nagelkerke pseudo $R^2$ | | 0.521 | | 0.600 |
| % of correctly classified cases | | 90.3 | | 93.7 |
| Farm-year observations | | 10745 | | 10745 |
| Number of farms | | 2922 | | 2922 |

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

fold higher than under the *Design00_06* baseline. The effect of the adjustment of AES payments in the 2011–2014 period (*Design11_14*) is still positive but lower than the impact of the most comprehensive RDP 2007–2010 policy review, which took into account the CAP Fishler reform decoupling the area payments. Similarly, the policy targeting, assigning priorities to farms in target areas (*Area*), has resulted in a positive impact on the remaining odds-ratio, all else being equal. There is consistency between our results and the findings of Murphy et al. (2014) for Irish REPS, where higher payment rates and institutional changes leading to a decrease in farmers' participation opportunity costs over time, increased their participation in more recent REPS.

In the estimated model, the time dependency of the log-odds is captured by a quadratic function. The signs of the linear and quadratic terms of *N_Years* show that the impact on the remaining log-odds ratio increases as the number of years under contract until time *t* increases for the average farmer, but the differential in logit hazard per year declines over time, the log-odds function being concave to the time axis. In line with the results obtained by Hynes and Garvey (2009) for the Irish REPS, by Läpple (2010) for organic farming and by Moser and Barrett (2006) for rice production practices in Madagascar, our findings confirm the relevant role played by time dynamics in the farmers' decision-making process. In our case, and consistently with the literature, the positive impact of time-dependence of the decision to remain in a given year is explained by the farmer slowly building up experience in actively managing hedgerows and buffer strips according to the scheme requirements. Moreover, it should be emphasized that the effect of the farmer's skills accumulation process can be captured solely by duration models, and not by conventional cross-section analysis (Burton et al., 2003; Moser and Barrett, 2006).

In the second specification of the model we included also the time-varying and time-invariant covariates expressing the influence on the remaining log-odds ratio of the farm and farmer's specific variables, as well as the time-varying lagged variable we considered as a proxy for the spatial neighbourhood effect.

The positive farm size (*F_UAA*) impact on log-odds is due to the fact that the larger the farm is at a given time *t*, the lower the impact of planting hedgerows along field edges on the overall farm income. Läpple (2010) and Hynes and Garvey (2009) had similar results when analysing other agri-environmental measures.

As expected, an increase in the area under AES (*AES_Increase*) during the spell positively influences the choice not to leave the scheme, being the result of a farmer's good evaluation of the impact of the measure after having experimented it on his/her farm.

In the case of sole proprietorship farms, a negative effect of farmer age (*Age_Class*) on the remaining odds-ratio is observed, e.g. the remaining odds-ratio of farmers younger than 41 years is about twice that of farmers aged over 65. This is in line with the duration analysis literature, where age is negatively related to the probability of staying in the scheme (Hynes and Garvey, 2009 for REPS; Kallas et al., 2010 for conversion to organic farming). However, both Moser and Barrett (2006) and Läpple (2010) found that the age effect is generally not significant.

According to the interpretation we gave to the *Ch_Owner* variable, *ceteris paribus,* when one younger family member takes over the farm management, the remaining odds-ratio at time *t* increases. In our view, this result is connected to an age-reduction effect during the spell, which positively impacts on the risk of remaining. This may be seen as a result of already-shared farm development pathways within the family, including the contractual obligations that are bound to the land. To the best of our knowledge, this effect has not yet been explored under a duration analysis framework. In the AES uptake literature – based on cross-sectional data – where this aspect is however mostly considered in terms of farmer's succession planning and not on actual taking over, negative or no significant effects are reported (Lastra-Bravo et al., 2015).

The personal motivations and attitudes towards environmental protection, expressed by the proxy *Thickets,* positively affect the decision to remain at time *t*, nearly doubling the odds-ratio, all else being equal. A similar effect, based on primary motivational and attitudinal data, was also found by Burton et al. (2003) and by Läpple (2010) for organic farming adoption.

Besides the above-mentioned 'learning by doing', 'learning from other farmers' – the neighbourhood effect – may also influence both the participation decision and, once a farmer is in the AES, the conditional probability of remaining at year *t* (Hynes and Garvey, 2009). In the literature, this effect is reported as explaining several factors affecting

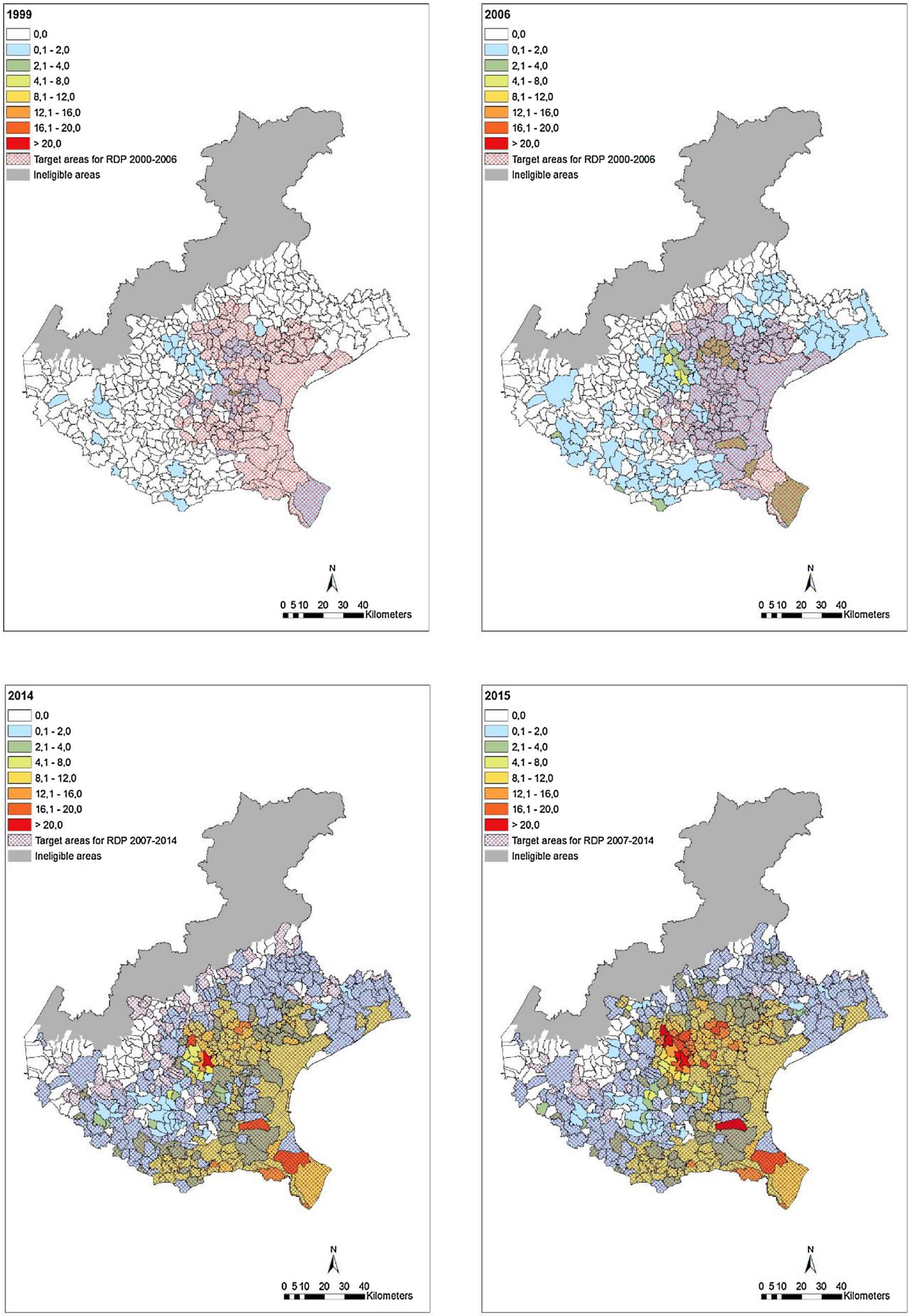


**Fig. 3.** Percentage of farms under AES in the same municipality, study area, selected years*.
*The 2015 call new-entries are also reported in Fig. 3, although not considered in our analysis.

the spatial innovation diffusion patterns: learning from other farmers, receiving communications, interactions, sharing experiences and imitation amongst neighbours (Raggi et al., 2015; Burton et al., 2003; Läpple and Kelley, 2014) help to lower the uncertainty of the impact of AES implementation on the farm management (Lewis et al., 2011) and the pressure to comply with social norms (Moser and Barrett, 2006; Chen et al., 2012). In our model, the neighbourhood effect at time *t* on the remaining log odds-ratio, expressed by the percentage of AES participants in the same municipality as the farm in the previous year (*LAG_Farms%)*, is statistically significant and remarkable: a 1% increase in *LAG_Farms%* increases the remaining odds-ratio by 3.3%. With our longitudinal perspective, this positive spillover effect is observed not only for farmers in the target areas, where it was expected and already shown by Raggi et al. (2015), but also outside them (Fig. 3). This highlights that the neighbourhood effect plays a significant role in AES persistence over time independently of the geographical targeting of the policy design. More generally, our results are consistent with those of Moser and Barrett (2006) for disadoption of some rice production practices and Lewis et al. (2011) for organic dairy farming.

## 6. Conclusions

Our work primarily aimed at estimating the impact of determinants on the conditional probability that a farmer remains one more year under the contract, after the five-year mandatory period, given that he/she was previously participating in the AES. In particular, we scrutinized the role played by farmer's and farm specific characteristics, farmer's learning process over time, neighbourhood effect and changes in policy design made by the regional authorities. To this end, we have fully taken into account the time dimension and the impact of time-varying factors, under a discrete-time duration analysis approach. By focusing our attention on the remaining rather than on the adoption perspective, we have enriched a still limited body of literature and offered an original contribution to a theme deserving more attention, given the stage of maturity AES are now reaching after more than two decades.

Our results have shown that a larger farm size amongst structural factors, a younger farmer as well as farm succession, with a new generation taking the lead, are all factors that positively affect the decision to remain. Similarly, the farmer's positive attitude towards the environment triggers longer durations in AES.

The effect of time emerged clearly in both models we estimated. The accumulation of experience, growing with the number of years under the AES contract, positively affects the remaining decision of the average farmer[5]: this result, not enough stressed by the literature, has been made available thanks to the duration approach. Specifically, for our case study area we found that the impact of the build-up of the farmer's experience on the decision to remain, although with decreasing rates, has a long persistence over time. The neighbourhood effect is also crucial for increasing the probability of remaining in the scheme one year more. This effect occurs in a dynamic perspective, regardless of policy targeting in specific areas. Lastly, the changes in policy tailoring and targeting made over time have a positive impact on the remaining in AES, contributing to reintroduce landscape and habitat features which had disappeared in the regional lowlands.

Our results are based on the entire population of AES participants and rely only on secondary data already available from public authorities. This is a strength of our work, as it allows to directly estimate the impact of AES design changes on farmers' decisions to remain or leave in a time-dynamic perspective without time-consuming and costly direct surveys. However, because of the fewer information available on each participant, our work is affected by a main limitation, i.e. the effect of individual (farmer's and farm) motivations and social factors is not so widely explored in comparison to analyses based on primary data. Caution should be exercised when extending our results to other regions sharing with Veneto a similar farming structure. In our case-study context, the interplay amongst the considered AES and the others could be neglected, because adoption of multiple measures was not strongly addressed in the policy design. In other regional contexts, this issue may be important and therefore should not be ignored. More generally, our results need to be corroborated by further analyses on other regions and other AESs impacting on the overall farming system.

Overall, considering the above-mentioned caveats, our results show that duration analysis could provide guidance to policy-makers to entice farmers to remain, in accordance with the conclusion of Hynes and Garvey (2009) that 'high degree of persistence may have some policy uses'. In our case, the following policy recommendations could be offered:

- the issue of taking enough time before considering the AES as fully established needs careful consideration; efforts in information and extension service provision cannot be restricted to the period prior to, or immediately following, the signing of the first contract, but need to be continued in the following years, also after contract renewal
- farmer-to-farmer information sharing networks, representing the social capital asset of the farm (Burton et al., 2003), should be identified and used to reinforce not only AES participation (Läpple and Kelley, 2014) but also AES persistence, as there seem to be neighbourhood effects in keeping farms in the scheme once they are in, as well as learning by doing effects that work in the same direction
- policy-makers should leverage young farmers to act as examples, spread information and technical knowledge on the scheme to the whole farming community, given that they are more inclined to remain in the AES. Rather than taking advantage of young participants to increase AES diffusion, public authorities just stimulated, through the priority scores system, young farmers to sign contracts in the 2000–2006 RDP
- changes in the policy design over time, when attempting to better suit the situation on the ground, to fine-tune and simplify the payment tiers, facilitate the decision to remain
- the gradual widening of target priority areas could be worth considering as a possible win–win strategy, taking advantage of the neighbourhood spillover effect on the decision to remain and saving financial resources previously assigned to higher payments for farmers remaining in the policy – i.e. maintaining hedgerows or buffer strips deriving from previous programming periods – rather than for new entries (as in the RDP 2007–2014)
- as there is a positive effect of farm size on the decision to remain, care should be paid as to how the payments are estimated, especially with regard to the higher impacts of participation costs on small farms. This issue was already considered by the regional policy-makers during the study period. However, it now needs further attention, given that large farms can today include hedgerows and buffer strips in the mandatory Ecological Focus Areas (EFA) required under the greening of the CAP first pillar, while small farms are exempt from EFA.

Thanks to our dynamic approach, which fully incorporates the time dimension into the analysis of the farmers' decision process to remain in the AES for a long period, such policy recommendations may provide policy-makers with more effective information than static approaches, enabling them to design more mature agri-environmental policies based on persistent voluntary participation, and therefore to achieve a more sustainable environmental change.

[5] The effect of time is explained as a self-learning effect by the scarce duration literature. However, we agree with a reviewer that this interpretation has to be empirically supported through farmers' surveys: we plan to better explore this issue through a questionnaire-based sample-survey.

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