Resilience of European farms with and without the CAP

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Abstract
Firms are able to survive only if they adapt appropriately in response to disturbances. The ability of a farm to continue after a disturbance is defined as resilience. To analyse the resilience of EU farms we explain exit and the number of adaptation strategies that farmers follow under two scenarios. The current CAP will be continued in the base scenario, while it will be abolished in scenario 2. The outcomes show that under both scenarios large more specialised farms with young farm heads are most resilient, and small more diversified farms headed by old farmers are least resilient.

Keywords: resilience, CAP reform, count model

1. Introduction

The term regime shift is used in ecology to describe a sudden, rapid transition of an ecosystem from one stable state to another. Such a transition occurs when a certain tipping-point or threshold is passed. Typical for regime shifts is the non-linear response of a system property to a disturbance in an exogenous driver. Often, such transitions cannot easily be reversed: the location of the tipping-point depends on the direction of the change, a property known as hysteresis. Well-known examples are the shift from low to high algae concentrations in shallow lakes (Scheffer and Carpenter, 2003) and the shift from grassy to woody savannahs (Rietkerk, et al., 2004). Besides ecosystems, the principles of tipping-points and regime shifts can be applied to a broad range of systems (Scheffer, et al., 2009). This paper presents an application to farms. Like ecosystems, farms can be seen as complex adaptive systems characterized by multiple feedbacks across their parts. They exhibit strong autonomous dynamics and a disturbance in an exogenous driver can result in non-linear responses with farm exit being an extreme example. However, despite the presence of regime shifts, systems often show a remarkable capability to retain similar structures and functionality after disturbances.

Disturbances are defined here as events that disrupt a farm business (cf. Janssen and Osnas, 2005). Disturbances can be idiosyncratic in nature, e.g. a farm family crisis or the impact of an outbreak of an animal disease or extreme weather conditions. On the other hand, disturbances can also be structural in nature – i.e. affecting the whole farm sector or all farm business in a certain sector, e.g. policy reforms. Disturbances can be sudden, i.e. a shock, but are often just gradual changes in an exogenous driver.

Farm resilience, the ability to cope with disturbances, is difficult to analyse empirically because disturbances differ in nature, size and over time, they are experienced differently by different farmers and mostly data can only be collected from the survivors of disturbances. It is therefore not surprising that there are only a few empirical studies on resilience and tipping-points available in the agricultural economics literature. The studies that do exist, often only deal with certain aspects of

resilience or a specific tipping-point, e.g. studies on farm exit (e.g. Kimhi and Bollman, 1999; Weiss, 1999; Glauben, et al., 2004; Dries and Swinnen, 2004).

In this paper we adopt a novel approach to overcome the problem of sample selection bias that would occur if only survivors of a disturbance – i.e. resilient farmers – are included in the dataset. To this end, farmers are asked about their future intentions – rather than past actions – in response to a disturbance. We investigate resilience in the case of two policy regimes (1) a fully liberalised Common Agricultural Policy (CAP) and (2) the continuation of the current CAP. Farmers are asked to indicate for both policy regimes if they will exit or not. Furthermore, if they claim to continue – i.e. the tipping-point is not reached - they are asked which alternative strategies they intend to implement to cope with the disturbances in both policy regimes. Adaptation strategies are plans of farmers to deal with disturbances. The strategies are focused around increasing or decreasing a single variable. Examples of these strategies are (dis)investing in machinery, borrowing money, changing off-farm employment, leasing or leasing-out land, buying or selling land, changing the amount of contract work on the farm, etc. In other words, the strategies involve changing the (ways of) employment of labour, land and capital on the farm.

Farmers that indicate that they will exit are considered to be the least resilient. Farmers that indicate that they implement many adaptation strategies as a result of a disturbance are considered to be less resilient than farmers that adapt only a few or no strategies. The number of strategies is considered to be a measure of farm resilience because adaptation strategies enable a farmer to cope with disturbances.

The purpose of this paper is to analyse farmers' resilience under different policy scenarios. Because we ask farmers about their future intentions with respect to exit decisions and adaptation strategies rather than past actions, we measure perceived instead of real resilience, and indicated instead of actually followed strategies.

The dataset consists of about 1400 farm households that were interviewed in 11 case-study areas in the EU representing different farming types and regions. Farms differed in their location, specialization, size, business environment and institutional environment. In the empirical section, we estimate a logit model of farm exit and two zero-inflated negative binomial models - one for each scenario - to explain the number of adopted strategies (Long and Freese, 2001). The estimation procedure for the latter model consists of two distinct processes: the inflate equation that corresponds to the binary model predicting the likelihood that the farm will not adopt any strategies and an equation for the number of strategies adopted.

The paper is organized as follows. Section 2 presents the data. Section 3 discusses the conceptual and the empirical models. Results are discussed in Section 4. The paper finishes with a general discussion and conclusions.

2. Data

Survey

In 2009, interviews were carried out as part of the EU project CAP-IRE on the future of the CAP in 11 case study regions in 9 countries of the EU: Emilia-Romagna (Italy), Macedonia and Thrace (Greece), Podlaski (Poland), North-East of Scotland (UK), Andalusio (Spain) South-East Planning Region (Bulgaria), Centre (France), Midi-Pyrénées (France), Lahn-Dill-District (Germany), Ostprignitz –Ruppin (Germany),

North-Holland (the Netherlands). Results were used from a questionnaire carried out with a mix of phone, postal and face-to-face interviews depending on the possibilities in the case study areas. The farm head or one of the farm heads was asked to fill in the pre-coded questions. The questionnaire contained questions about the farm and farm household, the business environment and the reaction to two scenarios.

Scenarios

The first scenario is 'the CAP stays as it is' and the second one is 'the abolition of the CAP'. The scenarios will be labelled as 'present CAP' and 'no-CAP' respectively. More precisely, farmers were asked for the present CAP scenario to "assume that prices, employment opportunities and other conditions remain stable at the January 2009 levels and that the CAP develops how it is currently planned. For points that have not been decided after 2013, assume they remain stable at the 2013 level till 2020". For the no-CAP scenario farmers were asked to consider the situation that "all CAP payments you receive (including rural development payments), and all other CAP instruments (e.g. milk quotas, cross-compliance) are removed in 2014. Farm households were asked to give their judgment about their future behaviour, i.e. exit or not and the number of strategies they were intending to implement, taking into account changes in their farm household that are expected to take place within the present CAP scenario and the no-CAP scenario.

Data

We will concentrate on 1368 farm households who responded that they will continue under the present CAP scenario and who either continue or quit farming under the no-CAP scenario. If a farm exits regardless of the disturbances ahead, it does not make sense to ask for strategies that they will follow when they continue. From the survey, several variables were derived. Table 1 gives an overview of the data used for the estimation. Column 2 (mean) shows the mean value of the variables of the farms that continue in the present CAP scenario. Column 4 does that for the 894 farms that indicate that they will continue in the no-CAP scenario. The first row of the table 'the average number of adaptations' gives the number of strategies farmers indicate they will follow under both scenarios. Part-time labour measures the share of farm household heads that have a job outside agriculture.

For the farmers that responded that they will continue in both scenarios the CAP abolition does not influence the decision about exit or continuation. There are 474 (1368-894) farmers that responded that they will continue in the present CAP scenario and that they will exit in the no-CAP scenario.

Table 1 – Data for the average farm

	Present CAP scenario (observations: 1368)		No-CAP scenario (observations. 894)	
Variable	Mean	Standard deviation	Mean	Standard deviation
Average number of adaptations	3.62	3.16	3.59	3.20
Percentage of farmland leased (%)	41.54	36.63	37.57	35.72
Percentage part-time labour (%)	27.44	32.48	23.99	29.84
Single farm payment per ha (€)	413.82	708.44	298.87	538.60
Income from farming > 50% (dummy)	0.69		0.76	
Household members (number)	3.73	1.40	3.75	1.43
Membership social organisation (dummy)	0.29		0.27	
Membership farmers union (dummy)	0.52		0.52	
Membership nature preservation organisation (dummy)	0.06		0.07	
Multifunctional non-farm activities (dummy)	0.19		0.19	
Area (ha)	98.77	258.96	99.81	276.71
Age (years)	46.45	12.47	45.33	13.00
Agricultural education (dummy)	0.61		0.65	
Higher education (dummy)	0.28		0.27	
Specialisation in livestock (dummy)	0.26		0.32	
Specialisation in crops (dummy)	0.35		0.35	
Regions:				
Emilia - Romagna, Italy (dummy)	0.11		0.14	
North-Holland, the Netherlands (dummy).	0.08		0.11	
Macedonia and Thrace, Greece (dummy)	0.19		0.10	
Podlaskie, Poland (dummy)	0.17		0.23	
North East of Scotland, UK (dummy)	0.06		0.07	
Southeast Planning Region, Bulgaria (dummy)	0.11		0.12	
Centre, France (dummy)	0.04		0.04	
Midi Pyrénées, France (dummy)	0.04		0.05	
Lahn-Dill-District, Germany (dummy)	0.04		0.02	
Ostprignitz-Ruppin, Germany (dummy)	0.07		0.04	
Andalucia, Spain (dummy)	0.10		0.07	

Source: CAP-IRE survey

3. Model

Theory

Theoretically a farm household will stop its enterprise when the discounted flow of farm profits is lower than the discounted flow of income from an alternative activity including (early) retirement. Many factors that play a role in the farm exit decision have been investigated in the literature. These factors can be divided into personal

characteristics (e.g. age), social capital (e.g. membership of farm organisations) and policy variables (e.g. farm payments) (see e.g. Kimhi and Bollman, 1999; Weiss, 1999; Glauben, et al., 2004; Dries and Swinnen, 2004). The decision whether or not to exit is given by

$$S_j = \begin{cases} 1 \; if \; \pi_j^f(z_j) \geq \pi_j^a(z_j) \text{ (farm continues)} \\ 0 \; if \; \pi_j^f(z_j) < \pi_j^a \; (z_j) \text{(farm exits)} \end{cases} \quad (1)$$

Where:
S_j: farm household j's decision whether to exit or not, π_j^f: discounted profit from farming for farm household j, π_j^a: discounted income from the best alternative for farm household j, z_j: vector of explanatory variables for farm household j.

In micro-economic theory not much attention has been paid to adaptation strategies as a reaction to disturbances. This is in contrast to the management literature where they are often considered as instruments of strategic management decisions (see e.g. FitzRoy et al., 1998; Ricketts, 2002). The adaptation strategies in this paper involve changing the (ways of) employment of labour, land and capital on the farm. On each of these topics there is a large amount of literature. However, it goes beyond the purpose of this paper to discuss this literature here.

Empirical model
Two models have been estimated. A first model will explain the indicated exit of farms in the no-CAP scenario. Second, a model has been estimated that explains the number of adaptation strategies. As farmers adopt strategies in both scenarios this model has been estimated for both scenarios separately. The variables described in Table 1 have been included in the empirical models.

It is expected that farmers who own a large share of their land (a small share of farmland is leased) are more likely to continue farming under both scenarios as they do not have to pay land rents which makes them less susceptible to disturbances. With more part-time labour and in case farms are involved in multi-functional non-farm activities, farmers have alternative sources of income making them also less susceptible to disturbances. On the other hand income alternatives could increase the probability of exit in case of CAP abolition.

The average single farm payment (SFP) per hectare is about 110 euro lower for farms who continue in the no-CAP scenario. This variable was included in order to determine the importance of the SFP for an individual farm. It is expected that the more important these payments are the more susceptible farms are to disturbances, and therefore the more likely they are to exit or to adopt more survival strategies. On the other hand large farms receive more support than small farms so one has to correct for farm size. If income from farming is relatively important we also expect these farms to be more susceptible to disturbances. Large farms are expected to be less susceptible to disturbances.

Memberships of social organisations, farmers unions and nature preservation organisations are expected to represent social and human capital. That could have two opposite effects. First, they make farms less susceptible to disturbances so they do need to adopt many strategies. Second, if they need to react to disturbances it enables farmers to adopt strategies more easily. Agricultural and higher education have the same effect.

Regional dummies represent regional differences in legal structures and social and cultural values that could affect the possibility to adopt certain strategies.

Age, type of specialisation and the number of household members could also influence the number of strategies adopted representing experience, past experiences with changes and possible strategies, and alternative sources of incomes respectively.

Adaptation strategies

Table 2 gives an overview of the adaptation strategies chosen in response to the disturbances in the present CAP scenario and the no-CAP scenario. Adaptation strategies are plans of farmers to deal with future disturbances. The strategies are focused around increasing or decreasing a single variable, e.g. changing the amount of land leased or employees hired. Farms either increase or decrease the variable of interest, e.g. land leased. We listed 15 different adaptation strategies.

About 55% of the farmers indicated to adopt between 1 and 5 strategies. About 20% did not choose any of the 15 strategies proposed. Adjusting the machinery park, adapting buildings, change in land ownership and land leasing, change in hiring employees and alter use of family labour on farm are mentioned most often as strategies.

Table 2 The percentage of farmers that alter the use of a strategy in the present CAP scenario (A) and no-CAP scenario (B) compared to the present situation. Significance level refers to whether or not the difference between both scenarios is significantly different.

	Number of strategies changed scenario...		
Variable	A	B	Significance level
Family labour on-farm	29%	30%	
Family labour off-farm	15%	20%	***
Employees	29%	28%	
Land ownership	28%	23%	
Land leasing	35%	29%	***
Land renting out	6%	7%	
Number of animals	28%	23%	***
Other activities	29%	21%	
Use of fertilizers and agro-chemicals	26%	29%	*
Use of water	18%	18%	
Buildings	30%	23%	***
Machinery	36%	27%	***
Contract work	19%	24%	**
Borrowing money	27%	39%	***
Contract production	18%	18%	

Statistical significance: * = $P < 0.10$; ** = $P < 0.05$; *** = $P < 0.01$

Estimation procedure

First, a logit model has been estimated to determine what the probability is that farms continue farming under the no-CAP scenario and which variables determine that

choice. Second, to analyse the number of strategies that farms indicate to adopt, a zero-inflated negative binomial model has been estimated. A Poisson model was rejected because of signs of overdispersion (see Verbeek, 2004: 212), that is, a greater variance than might be expected in a Poisson distribution. The dataset contains a relatively large number of zero observations (no strategies are adopted) which led to the rejection of the standard model in favour of a zero-inflated negative binomial model. A reason for not adopting a strategy could be that these farms consider themselves to be robust or they have difficulties to imagine what changes they may implement, and therefore, give a zero answer. The zero-inflated count model merges a binary logit with a negative binomial model (Long and Freese, 2001). The estimation procedure consists of two distinct processes: the inflate equation corresponds to the binary model predicting that the farm indicates to follow no strategies and an equation for the number of strategies farms indicate to adopt (count equation). The Vunong test (Long and Freese, 2001) supports the zero-inflated negative binomial model over the negative binomial model.

4. Results

Table 3 presents the results of the logit model of farm continuation.

Table 3 Marginal effects of Logit model on farm continuation (farms that exit in the no-CAP scenario compared to the present CAP scenario)[1].

Variable		
Percentage of farmland leased (%)	0.99	***
Percentage part time labour (%)	1.00	
Single farm payment per ha (€)	1.00	**
Income from farming more than 50 per cent (dummy)	1.34	*
Household members (number)	1.03	
Membership social organization (dummy)	1.11	
Membership farmers' union (dummy)	0.99	
Membership nature preservation organization (dummy)	1.51	
Multifunctional non-farm activities (dummy)	0.98	
Area (ha)	1.00	
Age (years)	0.98	***
Agricultural education (dummy)	1.11	
Higher education (dummy)	0.88	
Specialization in livestock (dummy)	1.37	
Specialization in crops (dummy)	1.51	**
Regions		
Emilia - Romagna, Italy (dummy)	4.37	***
North-Holland, the Netherlands (dummy).	6.19	***
Macedonia and Thrace, Greece (dummy)	0.63	*
Podlaskie, Poland (dummy)	5.01	***
North East of Scotland, UK (dummy)	3.38	***
Southeast Planning Region, Bulgaria (dummy)	3.10	***
Centre, France (dummy)	1.63	
Midi Pyrénées, France (dummy)	2.18	*

Lahn-Dill-District, Germany (dummy)	0.51
Ostprignitz-Ruppin, Germany (dummy)	0.62
Andalucia, Spain (dummy)	

Number of observations = 1368, statistical significance: * = $P < 0.10$; ** = $P < 0.05$; *** = $P < 0.01$

1: A number smaller than 1 implies that the variable has a negative effect on continuation. The opposite is true for a value larger than 1.

The marginal effect e^{β_k} is the exponential of the estimated coefficient β_k of the logit model. For $e^{\beta_k} > 1$ one can say that for a unit change of the variable the odds are e^{β_k} larger, for $e^{\beta_k} < 1$ the odds are e^{β_k} smaller. For example for each per cent of land leased extra, the odds of continuing the farm is 0.99 smaller, holding all other variables constant. So, A number smaller than 1 implies that the variable has a negative effect on continuation. The opposite is true for a value larger than 1.

Farm households that earn more than 50% of their income from agriculture are more likely to continue farming in the no-CAP scenario (marginal effect is larger than one). Farms that get a larger single farm payment per ha are less likely to continue (marginal effect is slightly smaller than one). So farmers that are more dependent on the CAP are more likely to exit when the CAP is abolished. Older farmers are more likely to exit in the no-CAP scenario compared to the present CAP scenario (marginal effect is smaller than one). Membership of farmers' unions and nature preservation organizations do not influence the probability to continue under the no-CAP scenario. Farms that lease a relatively large amount of land are less likely to continue in the no-CAP scenario (marginal effect is smaller than one). Land lease makes them more susceptible to shocks. Arable farms are more likely to continue (marginal effects are larger than one). The case study area dummies illustrate differences related to case-study specific factors such as the regional institutional environment, history and geographical characteristics.

Table 4 presents the estimation results of the equation explaining whether or not strategies will be adopted in the present CAP and the no-CAP scenario (inflate equations). Table 5 gives the results for the equation explaining the number of strategies adopted in both scenarios.

Table 4 Marginal effects for the binary equation of the zero inflated negative binomial regression[1]

Variable	Marginal effect Present CAP		Marginal effect No-CAP	
Percentage of farmland leased (%)	0.60		1.85	
Percentage part time labour (%)	1.49		1.17	
Single farm payment per ha (€)	0.86		1.27	
Income from farming > than 50% (dummy)	1.31		0.49	*
Household members (number)	0.71	***	0.59	***
Membership social organisation (dummy)	1.62	*	1.45	
Membership farmers' union (dummy)	0.60	**	0.89	
Membership nature preservation organisation (dummy)	0.52		2.08	
Multi-functional non-farm activities (dummy)	0.94		0.42	
Area (ha)	0.02	**	0.01	*
Age (years)	12.33	***	6.69	
Agricultural education (dummy)	1.38		0.63	
Higher education (dummy)	0.75		0.38	*
Specialization in livestock (dummy)	1.02		0.43	
Specialization in crops (dummy)	1.62	*	0.84	
Regions:				
Emilia - Romagna, Italy (dummy)	0.87		2.41	
North-Holland, the Netherlands (dummy).	0.06	**	0.31	
Macedonia and Thrace, Greece (dummy)	1.02		0.67	
Podlaskie, Poland (dummy)	0.60		5.71	
North East of Scotland, UK (dummy)	0.40		1.67	
Southeast Planning Region, Bulgaria (dummy)	0.12	***	0.74	
Centre, France (dummy)	1.46		0.38	
Midi Pyrénées, France (dummy)	0.44		0.76	
Lahn-Dill-District, Germany (dummy)	1.49		2.94	
Ostprignitz-Ruppin, Germany (dummy)	0.59		5.32	

Number of observations = 1368, statistical significance: * = $P < 0.10$; ** = $P < 0.05$; *** = $P < 0.01$

1: A number smaller than 1 implies that if the variable goes up by 1 then the number of strategies goes down. The opposite is true for a value larger than 1.

There are two explanations for the differences between the results for both scenarios in Table 4. First, the number of farms in the no-CAP scenario is smaller because farms exited because of the abolishment of the CAP, this has a negative effect on the significance of the results found. Second, farms that exit have different characteristics than those that continue. This has been investigated with the logit model presented in Table 3. In the present CAP scenario some farms can cope with disturbances while they cannot in the no-CAP scenario.

Larger farms are less likely to adopt strategies in both scenarios (marginal effect is smaller than one). The same holds for farms where the farm household has a large number of members.

In the present CAP scenario membership of a social organisation has a significantly positive effect (marginal effect is larger than one). Membership of a farmers' union has a significantly negative effect (marginal effect is smaller than one). Social capital apparently plays a role, but it can have a positive or negative effect. A reason for the difference could be that membership of a farmers' union is more likely for 'conservative' farmers that hope politics will solve their problems instead of dealing with them by adopting adaptation strategies. Membership of a social organisation would be in that case a way to increase social and human capital to be better equipped to deal with disturbances. In the no-CAP scenario neither variable plays a significant role although the signs are the same. This is probably due to the smaller number of farms that continue (see Table 3).

Increasing age of the farmers has a significantly positive effect in the present CAP scenario on the decision whether or not strategies are adopted (marginal effect is larger than one). This could reflect the experience older famers have gained during their live dealing with risks. In the no-CAP scenario this variable has no longer a significant influence. This may be because older farmers are overrepresented in the farms that exit as is confirmed by the results in Table 3.

Arable farms (specialisation in crops) are more likely to adopt strategies in the present CAP scenario (marginal effect is larger than one). This could be due to the fact that these farms, opposed to dairy farms, have more experience with dealing with uncertainty. This experience makes that they learned that uncertainty requires action. In the no-CAP scenario this variable is no longer significant. Apparently there is a relatively large number of arable farms among the farms that exit (which the continuation model confirms, see Table 3). The shock of CAP abolition is too large to cope with for small arable farms, e.g. because of the effect of the abolishment of the single farm payments.

Farms where a relatively large share of the income is coming from agriculture and where the education level is high are less likely to adopt strategies in the no-CAP scenario but not in the present CAP scenario (marginal effect is smaller than one). Apparently, there is a relatively large number of farms among the farms that exit with income coming from alternative sources and with farmers having a lower education level (again the continuation model confirms this, see Table 3).

Farms in North-Holland and the Southeast Planning Region are less likely to adopt strategies in the present CAP scenario (marginal effect is smaller than one). For North-Holland this could be due to the large share of dairy farms that do not feel the urge yet to deal with disturbances, and the large share of flower bulb farms that are not affected by the CAP as they do not receive any CAP subsidies. For Bulgaria the explanation could be found in the large former state farms that are already accustomed to a very uncertain environment. In the no-CAP scenario these results are no longer significant which could be due to the smaller sample.

Table 5 Marginal effects for count equation of zero inflated negative binomial regression on number of strategies per farm[1]

Variable	Marginal effect Present CAP		Marginal effect No-CAP	
Percentage of farmland leased (%)	1.18	**	1.24	***
Percentage part-time labour (%)	0.83	**	0.90	
Single farm payment per ha (€)	0.94	*	1.01	
Income from farming > than 50% (dummy)	1.10	*	0.98	
Household members (number)	1.03	**	1.02	
Membership social organisation (dummy)	1.28	***	1.19	***
Membership farmers' union (dummy)	1.02		1.27	***
Membership nature preservation organisation (dummy)	1.04		1.13	*
Multifunctional non-farm activities (dummy)	1.06		0.95	
Area (ha)	0.93		1.10	
Age (years)	0.49	***	0.42	***
Agricultural education (dummy)	1.10	**	1.01	
Higher education (dummy)	1.11	**	1.13	**
Specialization in livestock (dummy)	1.29		1.09	
Specialization in crops (dummy)	1.10	*	1.01	
Regions:				
Emilia - Romagna, Italy (dummy)	0.67	***	0.59	***
North-Holland, the Netherlands (dummy).	1.06		1.33	**
Macedonia and Thrace, Greece (dummy)	0.93		0.72	**
Podlaskie, Poland (dummy)	0.89		0.35	***
North East of Scotland, UK (dummy)	0.81	*	1.01	
Southeast Planning Region, Bulgaria (dummy)	1.93	***	1.44	***
Centre, France (dummy)	0.80	*	0.98	
Midi Pyrénées, France (dummy)	0.70	***	0.94	
Lahn-Dill-District, Germany (dummy)	1.08		0.93	
Ostprignitz-Ruppin, Germany (dummy)	1.07		0.89	

Number of observations = 1368, statistical significance: * = $P < 0.10$; ** = $P < 0.05$; *** = $P < 0.01$

1: A number smaller than 1 implies that if the variable goes up by 1 than the number of strategies goes down. The opposite is true for a value larger than 1.

Table 5 presents the number of strategies farmers indicate to adopt for both scenarios. There are two explanations for the differences between the results for both scenarios in Table 5. First, the number of farms in the no-CAP scenario is smaller, this has a negative effect on the significance of the results found. Second, farms that exit have different characteristics than those that continue (see Table 3).

The percentage of land leased has a positive effect in both scenarios on the number of strategies adopted (marginal effect is larger than one). Farms that lease a relatively large share of their land are less likely to continue (see Table 3), more land leased makes farms apparently more susceptible to disturbances, and therefore increases the number of strategies. Part-time versus full-time labour has a negative effect on the number of strategies adopted but only in the present CAP scenario. More

part-time labour implies that farmers have alternative sources of income making them less susceptible to disturbances. The reason that in the no-CAP scenario this variable is no longer significant could be caused by the fact that many of the farmers that exit are part-time farmers (which the continuation model confirms, see Table 3).

Although older farmers are more likely to adopt a strategy to cope with disturbances they adopt less strategies than younger farmers in both scenarios. Better educated farmers adopt more strategies in both scenarios. Farmers with an agricultural education also adopt more strategies but this is only significant for the present CAP scenario. In the no-CAP scenario this variable does no longer have a significantly positive effect. This may be caused by the fact that a relatively large amount of these farms decides to exit in case of CAP abolition (which the exit model confirms although the variable is not significant, see Table 3) and the smaller the number of farms in the no-CAP scenario.

Farmers that are relatively dependent on CAP support, as indicated by the single farm payment, are less likely to adopt a large number of strategies in the present CAP scenario. This is as expected. The single farm payment is not significant in the no-CAP scenario as there are no subsidies anymore. The continuation model confirms that farms that are dependent on CAP support are more likely to exit (see Table 3).

A large share of agriculture in total income has a significantly positive effect on the number of strategies adopted in the present CAP scenario this effect alters in sign and is no longer significant in the no-CAP scenario. For a farm in the present CAP scenario for which agriculture is important it seems obvious that strategies to cope with disturbances are found within agriculture because the strategies selected relate to agricultural practices (see Table 2). This explains the significantly positive effect in the present CAP scenario. Farms that decide to continue in the no-CAP scenario are large and specialised, and therefore less likely to adopt a large number of strategies to deal with disturbances (which the continuation model confirms, see Table 3). This explains that there is no significant effect of this variable in the no-CAP scenario.

Larger farms are less likely to adopt strategies to cope with disturbances (Table 5), and therefore, it is not surprising that farm size has no effect on the number of strategies farmers indicate to adopt to deal with disturbances.

Although farms where the farm household has a large number of members is less likely to adopt a strategy to survive they adopt more strategies. This could be due to the larger possibilities they have compared to smaller farm households. In the no-CAP scenario this variable is no longer significant which could be due to the smaller number of farms in the case of the no-CAP scenario.

Membership of a nature preservation organisation and a farmers' union have no significant effect on the number of strategies adopted in the present CAP scenario but do have a positive effect in the no-CAP scenario. This could be because these memberships in a more uncertain environment (no-CAP versus CAP) could provide information that helps to construct social and human capital that makes it easier to deal with disturbances. For the same reason membership of a social organisation has a positive effect in both scenarios.

The regional dummies show a very mixed result. This could be due to regional differences in legal structures and social and cultural values that could affect the possibility to adopt certain strategies.

5. Discussion and conclusions

Farms that decide to exit because of CAP abolition are the least resilient to the new regime that CAP abolition represents. Results show that farms that indicate to exit are the ones that are most dependent on CAP support, lease a relatively large share of their land, have old farm heads, and are part-time and diversified farms.

The results also indicate that - besides being less likely to exit - large, more specialised farms with young and highly educated farm heads adopt no or fewer adaptation strategies both under the current CAP and in the situation where the CAP is abolished. These farms are clearly most resilient. They do not need (m)any strategies to cope with disturbances in either of the two scenarios. On the contrary, small and less specialised farms that are relatively dependent on CAP support and have older and less educated farm heads indicate that they adopt a lot of strategies to deal with disturbances even if the present CAP is continued.

More in general a higher level of education and membership of social organisations enable farms to adopt more strategies. Both factors are related to human and social capital.

The results clearly show that there are differences between farmers, farms, and regions with respect to resilience and tipping-points. As a result, policies that try to improve resilience of farms to future disturbances need to be tailor-made. This is extremely relevant given the upcoming CAP reforms. However, besides disturbances linked to CAP reform the approach used in this research can also be applied to other disturbances, e.g. to climate change or on-going globalisation.

A caveat of the model is that the strategies in the dataset are based on intentions related to two not very realistic scenario's. In that sense this research could be considered as a choice experiment (e.g. McFadden, 2005). So it is not actual behaviour that is studied but indicated behaviour. Despite this caveat the model is valuable because it is one of the first attempts to model and empirically study the resilience of farms and the influence of a wide variety of factors such as farm and farm household characteristics, location and membership of social organisations on resilience.

References

Dries, L., Swinnen, J.F.M. 2004. Foreign Direct Investment, Vertical Integration, and Local Suppliers: Evidence from the Polish Dairy Sector. *World Development*, 32(9), 1525-1544.

European Commission, 2010. The CAP towards 2020: Meeting the food, natural resources and territorial challenges of the future. Brussels, COM(2010) 672 final.

FitzRoy, F.R., Acs, Z.J., Gerlowski, D.A. 1998. *Management and Economics of Organization*. Prentice Hall Europe, London.

Glauben, T., Tietje, H., Weiss, C.R. 2004. Intergenerational Succession in Farm Households: Evidence from Upper Austria. *Review of Economics of the Household,* 443-462.

Holling, C.S. 1973. Resilience and Stability of Ecological Systems. *Annual Review of Ecological Systems* 4, 1–24.

Janssen, M.A., Osnas, E.E. 2005. Adaptive Capacity of Social-Ecological Systems: Lessons from Immune Systems. *EcoHealth* 2, 93-101

Kimhi, A., Bollman, R. 1999. Family Farm Dynamics in Canada and Israel: The Case of Farm Exits. *Agricultural Economics* 21, 69-79.

Long, J.S., Freese, J. 2001. *Regression models for categorical dependent variables using STATA*, Stata Press Publication, College Station, Texas.

McFadden, D.L., Bemmaor, A.C., Caro, F.G., Dominitz,J., Jun, B., Lewbel, A., Matzkin, R.L., Molinari, F., Schwarz, N., Willis, R.J., Winter, J.K. 2005. Statistical Analysis of Choice Experiments and Surveys, *Marketing Letters* 16(3), 183-196.

Perrings C. 1998. Resilience in the dynamics of economy-environment systems, *Environmental and Resource Economics* 11(3-4), 503-520.

Ricketts, M. 2002. *The economics of business enterprise: an introduction to economic organisation and the theory of the firm*. Edward Elgar, Cheltenham.

Rietkerk, M., Dekker, S.C., de Ruiter, P.C., van de Koppel, J. 2004. Self-organized patchiness and catastrophic shifts in ecosystems. *Science* 305(5692), 1926-1929.

Scheffer, M., Carpenter, S.R. 2003. Catastrophic regime shifts in ecosystems: Linking theory to observation. *Trends in Ecology and Evolution* 18(12), 648-656.

Scheffer, M., Bascompte, J., Brock, W.A., Brovkin, V., Carpenter, S.R., Dakos, V., Held, H., van Nes, E.H., Rietkerk, M., Sugihara, G. 2009. Early-warning signals for critical transitions. *Nature* 461(7260), 53-59.

Verbeek, M. 2004. *A guide to modern econometrics*, John Wiley and Sons, Ltd, Chichester.

Weiss, C. 1999. Farm Growth and Survival: Econometric Evidence for Individual Farms in Upper Austria, *American Journal of Agricultural Economics*, 81, 103–116.