EU farmers' intentions to invest in 2014-2020: The role of attitudes towards risk, the environment and innovation

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Abstract

Purpose – This article aims to analyse the determinants of investment intentions in EU farms using a purpose-built survey of 780 farmers of 6 EU countries interviewed in spring 2013.

Design/methodology/approach – We examine the determinants of investments decisions in land, machinery, building, training and quota and production rights. More specifically, we want to understand the role of farmers' attitudes compare to more structural characteristics of the farm and the farm household.

Findings – The analysis shows that farmers can be categorized in three clusters on the basis of their attitudes towards risk, the environment and innovation: the involved-traditional farmers, the indifferent farmers and the entrepreneur farmers. As expected, farmers in the entrepreneur cluster indicated more intentions to invest than farmers in the other two clusters, and this holds for all the types of investments. Moreover, the results of a multivariate probit model show that cluster variables have significant effect in the willingness to invest in building and machinery, as well as in land and training, but to a lower extent. These results confirm that farmers' attitudes are important drivers of the intentions to invest and that they are not correlated with structural variables.

Originality/value – This paper contributes to the limited literature on farmers' investment decisions at EU-level. This research provides a unique data source covering 6 EU countries (Czech Republic, Germany, Spain, France, Italy, Poland) and four different farm types (arable crops, livestock, perennial crops and mixed farms).

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Introduction

Farm production is a function of several inputs, including the current level of capital (building, machinery, land), which depends on past investment decisions. In the classical investment theory, it is generally accepted that farmers will invest in a specific asset if the sum of the discounted expected benefits over the life of the asset are higher than the investment costs. In a world with imperfect credit markets, the lack of financial resources can nevertheless create barriers to investment and explain the non-realization of profit maximizing investments. As a result, income support to farmers through the Common Agricultural Policy (CAP) is expected to impact investment, by increasing the self-financing possibility, but also the access to credit. In this framework, many studies have focused on the role of policy (and particularly the CAP) to explain investment decisions (see among others (Latruffe, Davidova et al. 2010; Viaggi, Raggi et al. 2010; Viaggi, Bartolini et al. 2011; Viaggi, Raggi et al. 2011; Michalek, Ciaian et al. 2013).

However, the idea that direct payments and investment support measures have a significant impact on investment decisions has been challenged by empirical studies (Gallerani, Gomez y Paloma et al. 2008; Viaggi, Bartolini et al. 2011; Michalek, Ciaian et al. 2013). The limited success of such measures to induce widespread changes to the farming industry is one factor that has led to an increase in the importance of understanding the individual response of farmers to policy measures, and an increase in the application of "behavioural approaches", defined as one that focuses ‘‘on the motives, values and attitudes that determine the decision-making processes of individual farmers’’(Morris and Potter 1995). In general, such approaches view behaviour as a combination of motivational factors and structural features that constrain, facilitate and, at the same time, reflect the motivational preferences of the farmer (Burton 2004). Whereas such research line has already be extensively developed to explain farmers' conservation decision (e.g. participation in agri-environmental scheme) (Gasson and Potter 1988; Morris and Potter 1995; Beedell and Rehman 1999; Beedell and Rehman 2000; Ahnström, Höckert et al. 2009), research focused on behavioural factors as a determinant of investment behaviour is more limited (Bergevoet, Ondersteijn et al. 2004).

Even if the literature on the behavioural drivers of investment decisions is limited, previous research has shown that investment decisions very often do not conform to classical investment theory (Jacobsen 1989). It is acknowledged that farmers do not necessarily indulge in economically optimal decision-making, but instead may optimise social, intrinsic and/or expressive goals (Simon 1957). Recent empirical studies emphasise the role of non-policy variables in determining farmers’ investment behaviour, such as farm households' characteristics (e.g. demography, succession) and the surrounding environment (e.g. wage outside farming, quality of life in rural areas, society's attention towards agricultural practices, social norms in the farmer community) (Vesterlund Olsen and Lund 2009). Moreover, given the present high level of uncertainty surrounding farming (uncertainty regarding agricultural prices in the short term, the future of the CAP in the medium term and climate change in the long term), behavioural components such as farmers' perceived behavioural control and attitudes toward risk are likely to play a fundamental role in agricultural decisions (Just 2008), and can explain deviation from profitable investment.

The paper argues that farmers' investment decisions can be understood not only in terms of their structural situation but also as an expression of the values and motivations which underlie behaviour. We analyse EU farmers' investment intentions on the basis of collected in a purpose-built survey carried out in 6 EU countries in spring 2013. We examine the determinants of investments decisions in land, machinery, building, training and quota and production rights. A model is proposed, in which farmers attitudes interacts with structural characteristics of the farm and household in influencing willingness to invest. The paper is structured as follows. Section 2 presents the methodology used and the justification for the selection of variables as suggested by prior studies. Results are presented in section 3. Section 4 provides conclusive remarks.

I. Methodology and data

Theoretical framework

The design of the questionnaire and the analysis of data are based on the theory of Planned Behaviour (TPB). This theory states that: (1) intention is a good predictor of planned behaviour; (2) a person's intentions are influenced by attitudes, subjective norms, perceived behavioural control, and past behaviour; and (3) intentions completely mediate the influences of attitudinal variables so that no direct path from attitude to behaviour can be hypothesised (Ajzen and Madden 1986; Ajzen 1991).

The reliance on intentions data is becoming increasingly common when studying farmers' future decisions and adjustment to potential changes in their environment (Bougherara and Latruffe (2010), Bartolini and Viaggi (2011), Raggi et al. (2012)). In practice, the relationship between intentions and behaviour as assumed by the TPB can be complicated by barriers to expression of the behaviour or by a lack of skills (Van der Pligt and de Vries 1995). Despite these potential limits, previous empirical research has shown that stated intentions are a reasonably good predictor of realised actions in the case of farm investments (Lefebvre, Raggi et al. 2013). Moreover, intention surveys have other value such as revealing farmers' frame of mind and expectations about the evolution of their environment and business confidence, which is otherwise difficult to capture (Thomson and Tansey 1982; Harvey 2000). In this study, farmers were asked whether or not they intended to invest in the period 2014-2020. This period corresponds to the next CAP programming period. Intentions of investments were then detailed according to investment type (land, buildings, machinery and equipment, quota and production rights, training), investment value, planned date for investment, ways of financing this investment, and rationale for the investment.

We further describe in this section how the factors identified in the literature as potential determinants of investment on-farm were included in the questionnaire.

Potential determinants of on-farm investment

We classify these determinants into four categories: the farm structural characteristics, the financial situation of the farm, the farmer socio-demographic characteristics and their attitudes.

Farm structural characteristics

According to neo-classical economic theory, new investments are realized when the sum of the discounted expected benefits over the life of the equipment are higher than the investment costs. In the absence of data on the expected returns from each particular investment, variables capturing farm structural characteristics can be used as proxies to explain investment decisions. We can expect the needs and the expected benefits from investment to be impacted by farm size, specialization, location …

Farm size is a potential determinant of investment intentions. Largers operating larger acreages are more likely to have a larger asset base from which to draw resources to invest. Larger operations also benefit from economies of scale and better managerial capacities, that can affect willingness to innovate and risk attitudes (Sherrick, Barry et al. 2004). However, decreasing marginal benefits associated with increasing size may restrain very large farms from further investments. Moreover, small farms may have higher propensity to invest to expand farm size. In the study, farms are classified as small, medium or large according to their total Utilized Agricultural Area (UAA) and total livestock units (LSU).[1]

Variables accounting for the farm specialization must be taken into account as they determine the investment likely to be realized and the return from investment. Four farm types are covered by the survey: arable crops, livestock, permanent crop and mixed farms. The survey includes information on area grown, average prices and yields over the last 5 years for each crop or livestock categories (restricted to the farm activities contributing most to farm income).

Potential return from investment can be impacted by farm location through differences in agricultural productivity, climate and farm-gate price from agricultural production across regions. Moreover, the transaction costs associated to any investment can also vary across regions (especially for land investments). The database includes information on the NUTS2 region were the farm is located, as well as whether it is in plain, hill or mountain.

The legal status of the farm is also likely to impact investment decisions as the farmer's objectives and room for manoeuvre may be different if he is an individual farmer or if he represents a legal entity such as a cooperative or a society. Individual farmers may have more flexibility in their decision-making, but also face greater financial constraints. The overall effect of being an individual farmer on investment is therefore ambiguous.

Financial resources

In the absence of fully efficient financial markets, the financial situation of the farm can be an important driver of investment.

Wealth is expected to impact insurance decisions through the financial resources available to fund the investment, as well as through its impact on access to credit and risk aversion. Whereas it is difficult to collect direct information on the total wealth, or even net income of the farm household, the gross margin from the main activities can be calculated, based on the price and yields information. In addition, data were gathered on the income from other non-

[1] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:LSU

farming activities on the farm, as well as off-farm income. The questionnaire also included a question on the hypothetical wage in an alternative profession that would cause the farmer to stop farming.

Debt and liquidity constraints are also strongly expected to affect investment through their impact on farmers' ability to finance a new investment and to obtain capital for new investments (Vesterlund Olsen and Lund 2009). More liquidity constrained farmers would invest less ceteris paribus. Information on access to credit was collected (credit obtained in the past, including those still running).

CAP payments are an additional source of income for most farmers. Farmers were asked about the payments they receive from the CAP, including direct payments and rural development policy payments. Structural investment, investments that improve environmental quality or animal welfare, stimulate diversification, or investments related to take-over of farms can receive support within the axis 1 of the rural development policy (Council Regulation (EC) No 1698/2005). Information on application to investment support subsidies in the last 4 campaigns was collected.

Farmer characteristics

The questionnaire include questions on the socio-demographic characteristics of the farmer (age, gender, education, years of experience, share of working time dedicated to the farm) and the structure of the farm household, since they are important determinants of the behavioural factors likely to explain deviation from profit-maximizing investments. The stage of the farm household life cycle, often approximated as the owner's age, and the expectations regarding the continuation of farming activity (approximated by the presence/absence of a successor and whether he is from the family or not), are also likely to explain investments. Older farmers may not wish to farm as actively as younger farmers and therefore invest less (Weiss 1998). Compared to older farmers, it is hypothesized that younger farmers wish to expand their operations and wish to increase the income. But younger farmers may not be able to invest because of inexperience or financial constraints. Age can also be a proxy of farmers' risk aversion, which is likely to impact on investment under uncertainty (Knighta, Weirb et al. 2003). The farmer's level of education can also be considered a key element in explaining different behaviours in the presence of transaction costs, which can constitute noteworthy constraints to investments, especially for land transactions (Allen and Lueck 2002). Higher education can favour decision planning, therefore impacting on the intention to invest.

Farmers' attitudes

Besides socio-demographic characteristics, we wanted to investigate whether attitudes have an influence on farmers' decision making and, more specifically, on their willingness to invest. Attitude is a disposition to respond favourably or unfavourably to an object, person, institution or event (Kim and Hunter 1993). An attitude is (a) directed towards an object, person, institution, or event; (b) has evaluative, positive or negative, elements; (c) is based on cognitive beliefs towards the attitude-object (i.e., the balancing between positive and negative attributes of an object leads to an attitude); and (d) has consequences for behaviour when confronted with the attitude object (Van der Pligt and de Vries 1995). In that framework, we focus on farmers attitudes towards risk, innovation and the environment, considered as potential objects relevant for investment intentions.

To measure the attitudes towards risk of the farmers, we developed a questionnaire based on the scale developed by Hansson & Lagerkvist (2012). The farmers were asked "How likely are you to ever find yourself in each of the following situation?". Their original list of situations consisted of two parts: 25 situations with expected risk-reducing benefits covering aspects of financial, production, environmental and social risk management, and 25 situations perceived as risky. This second group is actually made of the same strategies than the first group, but worded as the negative of the suggested strategies in the first group (risk-increasing strategies). For instance, "Paying bills on time" was suggested as a risk-decreasing action in the first group, while "Not paying bills on time" as a risk-increasing action in the second group. In our study, we limit the questionnaire to 13 items from the original list. For the attitudes towards the environment and innovation, farmers were asked "To what extent do you agree or disagree with the following statements?". Farmers' environmental attitudes were evaluated using 7 items, 4 of which were developed by Vogel (1996) and the others invented by the authors. Attitudes towards innovation were measured by means of 8 items, based on a scale developed for consumer attitudes (Goldsmith and Hofacker 1991), completed by a list of items on openness to new ideas in business (Edwards-Jones, Deary et al. 1998). The list of attitudes items are described in conjunction with the presentation of the factor analysis results in table 1.

Survey design

The data were collected in spring 2013, through structured face to face interviews, using the Paper Assisted Personal Interviewing (PAPI) methodology. A total of 780 farms were interviewed in 6 countries (Czech Republic, Germany, Spain, France, Italy, Poland), covering four different farm types (arable crops, livestock, permanent crop and mixed farms), as well as different farm size.

The sample was selected based on a two-stage cluster sampling procedure. Three to four NUTS2 regions were selected in each of the six countries, on the basis of being areas in which a high proportion of particular farming systems (arable crops, perennials, livestock, mixed farms) are represented, both in respect of the number of holdings and the overall cropping areas or numbers of livestock units, but also the economic importance of each farming type in that region in terms of standard output and labour employed. The sample was then selected at random within those region-farm types cells, with soft quotas applied in order to achieve a reasonable distribution of farms selected by farm size (secondary sampling units).

In order to account for disproportionate stratification and non-response, each observation has been weighted in the final dataset (linear weighting procedure, using Eurostat data (FSS 2010)). The sample-size of n=780 accumulated to n= 1,700,000, representative of farmer population in the studied countries. In the following, analyses are performed based on the weighted data. As such, the results of these analyses are representative for the universe of farmers in the studied countries.

II. Results

We analyse here the determinants of the intentions to invest, with a focus on the relative role of structural characteristics of the farm and the farmers versus farmers' attitudes. All of our estimates are obtained using the survey (svy) commands in Stata designed to produce standard errors corrected for complex survey design.

Overall, it was found that 57% of farmers are willing to invest in the period 2014-2020. 71% of investors planned to invest in machinery and equipment, while investments intentions in land, buildings, training and quota and production rights are less frequent (37% land, 36% buildings, 29% training, 5% quota and production rights). We can observe significant difference across farm types and farm size in the willingness to invest and type of investment intended (figure 1).

In order to analyse the role of behavioural factors as determinants of the intention to invest, we first reduce the set of attitudes items to a few common factors of high performance. In a second step, a cluster analysis is performed to search for groups of farmers belonging together based on their similar attitudes. Lastly, we verify whether the groups of farmers identified with the cluster analysis vary systematically in their willingness to invest.

Factor analysis

The aim of the first step of the analysis was to get insight into common factors underlying the attitudes statements of the farmer. Data reduction was performed by means of factor analysis for each category of items (risk, environment, innovation). The aim of this analysis is to uncover the underlying structure through the combination of items in factors. These factors need to explain as much of the variance of the original set of items as possible.

We have analysed risk items by means of confirmatory factor analysis based on the division between risk increasing and risk decreasing situations. It allows reducing the number of variables associated with risk attitudes from 13 items to 2 factors. Applying exploratory factor analysis to the data reduced the number of variables related to the environmental attitudes from 7 items to 3 factors, and related to innovation attitudes from 8 items to 3 factors. Some of the items were removed to improve the model fit. Table 1 shows average scores for each item retained, as well as the factor loadings of the different attitude items. For further analysis, the original set of items related to attitudes is replaced by a set of variables created from the factor scores.

Cluster analyses on farmers' attitudes

A two-step cluster analysis was used to explore whether farmers could be segmented into groups based on their attitudes In a first step, hierarchical cluster analysis is performed to determine the central vector-scores of the attitudinal factors. Then, K-means-clustering is done to obtain the final clusters (Arai and Barakbah 2007). A three-group-solution is retained, based on the three validity criteria (Garson 2010): (1) Size: all clusters should have enough farmers to be meaningful; as the three clusters are distributed with 40%, 35% and 25% of the farmers this criterion appears to be fulfilled. (2) Meaningfulness: the meaning of each cluster should be readily intuited from the constituent variables used to create the clusters. (3) Criterion validity: cross-tabulation of clusters with other variables known from

the literature as reflecting the cluster concept should be used as validity test. In lieu of this, we use the cross-tabulation with willingness to invest as a test of validity.

Table 2 describes the clusters and the mean score of each of the attitude factors found with the factor analysis. The largest cluster (cluster 1) is defined primarily by farmers highly likely to be in situations reducing the risk they face, rather than risk-increasing behaviours. They consider farming is not harming nature and is innovative, but they are not interested by high-tech farming equipment. Thus we will refer to farmers of this cluster as the involved-traditional farmers. Farmers in cluster 3 exhibit the opposite tendency: they score above average on almost all items. They appear to be highly likely to use the risk-reducing strategies, but also to find themselves in the situations perceived as risky. They show highest interest in innovation and in the environment. Thus we will refer to farmers of this cluster as the entrepreneur farmers. Finally, farmers in cluster 2 are rather indifferent, with below average scores in most of the items. They pay little attention to risk management actions (both those with expected risk decreasing benefits and those perceived as risk increasing), limited interest in innovation and in the environment. Importantly, farmers are rather alike across clusters with regard to structural variables such as farm size and distribution across farm specialization and legal status, indicating that the cluster profiles do not reflect underlying structural factors, but individual attitudes (table 3).

Attitudes and willingness to invest

We first analyse the associations between clusters and willingness to invest using simple cross tabulations and non-parametric correlation measures (table 4). As expected, farmers in the entrepreneur cluster indicated more intentions to invest than farmers in the other two clusters, and this holds for all the types of investments (figure 2). 74% of farmers in the entrepreneur cluster have stated an intention to invest, compared to 58% in the involved-traditional farmers cluster and 42% in the indifferent cluster. The differences are statistically significant. The highest difference between clusters concerns investment in training and machinery, while the differences across clusters are lower (or not significant) for land and building investments.

Our database offers the opportunity to examine the relative importance of attitudes compare to more structural factors in explaining farmers' investment intentions, and to do so for various categories of investments (land, machinery, building and training)[2], taking into account the possibility of simultaneous investments and the potential correlations among these investment decisions.

[2] Since few farmers have stated an intention to invest in quota and production rights, such investments are not included in the analysis. Moreover, not all the variables presented in section II have been included in the model at this stage. Further estimations including more variables will be run by the time of the conference.

We rely on a multivariate probit estimation procedure, which allows the unobservables in the decision to invest in land, machinery, building and training to be jointly distributed.[3] The four equations were simultaneously estimated using the mvprobit program for Stata software (Cappellari and Jenkins 2003). It uses Geweke-Hajivassilou-Keane (GHK) simulator for probabilities and a maximum simulated likelihood procedure. Since the procedure used involves simulation, one of the key choice is the number of draws to consider. For moderate to large sample sizes, setting the number of draws (R) equal to an integer approximately equal to the square root of the sample size is considered appropriate (Cappellari and Jenkins 2003). Therefore, each model was run with 25 draws.[4] This program does not allow taking into account weights. The results of the multivariate probit model are presented in table 6. For comparison, we also report the parameter estimates from an equation-by-equation individual probit approach in table 5. In the individual probit models, we use sampling weights and correction for stratification (svy: probit command in Stata).

For the individual probit equations, we obtain a relatively good fit of the model to the data (Hosmer–Lemeshow goodness-of-fit test (Archera, Lemeshow et al. 2007)), except for WTI_building, for which we can reject the hypothesis that the model fits. In the multivariate probit model, the likelihood ratio test suggests that the joint estimation of the four types of investments through the multivariate probit is preferable to the naive individual probit models (H0: the correlation coefficients among the four binary variables is jointly equal to zero). Moreover, all the pairwise correlation coefficients are positive and significant at the 1% level. This supports the hypothesis that the error terms in the different equations are correlated and a multivariate probit approach is appropriate in this case. The positive sign of the correlation between the error terms of the different equations suggest that investments in each category are complementary.

The coefficients of the structural farm characteristics and the farmer socio-demographic variables have the expected signs. Small farms are less likely to invest (compare to large farms) in all categories of investment but training, but there are no significant differences between medium and large farms. Specialization seems to be an important factor, with farms specialized in arable crops intending to invest less in building (compare to mixed farms) but more in machinery and training. However, the estimations show no significant differences across perennial crops, livestock and mixed farms. Finally, location variables seem to be important to be included, to control for many unobservable differences across countries in such multi-countries studies. Not surprisingly, southern European countries (Spain and Italy) have less frequent intentions to invest (compare to Poland), which can be explained by the economic crisis they face and its effects on the credit market. France is impacted to a lower extent (only for land and building).

[3] The error terms are assumed to have multivariate normal distributions with mean vector equal to zero and a covariance matrix R with diagonal elements equal to one, while the off-diagonal elements are to be estimated. By allowing the off-diagonal elements of Matrix R to differ from zero, the multivariate probit model accounts for the effect of unobserved characteristics that potentially influence at the same time the intentions to invest in two categories by the farmer.

[4] There were only small differences in the results under alternative choices of the number of draws, although the mvprobit routine had trouble achieving convergence when a much higher number was used.

Concerning the socio-demographic variables, younger farms are more willing to invest, while female farm heads have declared less future investments. Farmers with no successor known at the date of the survey are less likely to invest in land and building, but this variable have no impact on the intentions to invest in training and machinery. This is can be explained by the differences in the life time of these different assets.

Finally, we obtain interesting results to address the question of the relative importance of attitudes compare to more structural variables. Indeed, we observe that both cluster variables have a significant coefficient in the willingness to invest in building and in machinery equations, after controlling for the farm and farmer characteristics. In the land investment and training equations, only the variable corresponding to the group of indifferent farmers (cluster 2) is significant. It suggests that, as already highlighted in figure 2, entrepreneur farmers are more likely to state an intention to invest than the involved-traditional farmers and the indifferent farmers. Interpretation of the result will be improved in the next version of the paper.

III. Discussion

Analysing a unique data source covering 6 EU countries (Czech Republic, Germany, Spain, France, Italy, Poland) and four different farm types (arable crops, livestock, perennial crops and mixed farms), we found that farmers can be grouped in three clusters on the basis of their attitudes towards risk, the environment and innovation: the involved-traditional farmers, the indifferent farmers and the entrepreneur farmers. Moreover, we found that farmers are rather alike across clusters with regard to structural variables such as farm size and distribution across farm specialization and legal status, indicating that the cluster profiles do not reflect underlying structural factors, but individual attitudes.

As expected, we found that farmers in the entrepreneur cluster indicated more intentions to invest than farmers in the other two clusters, and this holds for all the types of investments. Moreover, the results of a multivariate probit model show that cluster variables have significant effect in the willingness to invest in building and machinery, as well as in land and training, but to a lower extent. These results confirm that farmers' attitudes are important drivers of the intentions to invest and that they are not correlated with structural variables. The results imply that it is important for policy makers to implement a broad array of policy instruments for each policy objective (incentive-based, information dissemination, mandatory regulation), given that farmers are driven by different types of motivation before investing.

In this article, we restrained the behavioural factors to farmers' 'attitudes', yet reliance solely on the attitude construct is widely acknowledged in the social psychology literature as inappropriate and unlikely to disclose any relationship with behaviour (Burton 2004). According to Burton (2004), to improve the behavioural approach requires to pay more attention to the role of subjective norms in decision-making, to obtain a measurement of perceived behavioural control, and investigate the role of identity in decision-making. Interestingly, some of the items included in the attitude questionnaire and in the factor analysis capture some of these dimensions. For example, the items "Farmers are the best protectors of the natural environment, even if mistakes are made from time to time" or "Agricultural activities today undermine the natural balance in the environment" can be

interpreted as indicator of the perceived behavioural control. The item "Compared to other farmers of my neighbourhood, I sue a lot of high technology products and machinery" can be a measure of social norms. A more systematic application of the theory of planned behaviour will be adopted in the next version of the paper.

The model could be also improved by inclusion of past behaviour, barriers and skills. While often discarded in the empirical application of the theory of planned behaviour in agricultural studies, all these elements are also part of the theory. The questionnaire included some variables likely to be useful in that respect: investment realized in the past (past behaviour), financial situation (barriers) and experience and education (skills). They will be taken into account in the next version of the paper.

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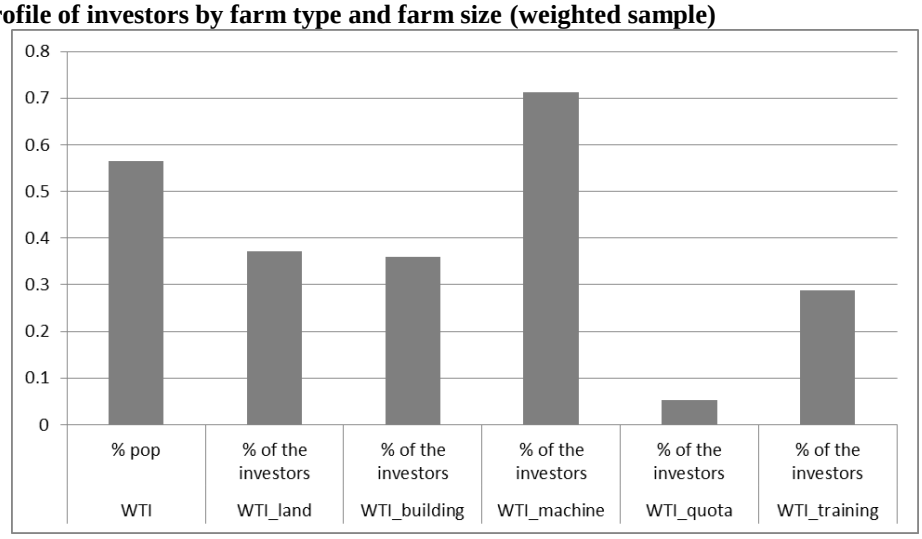
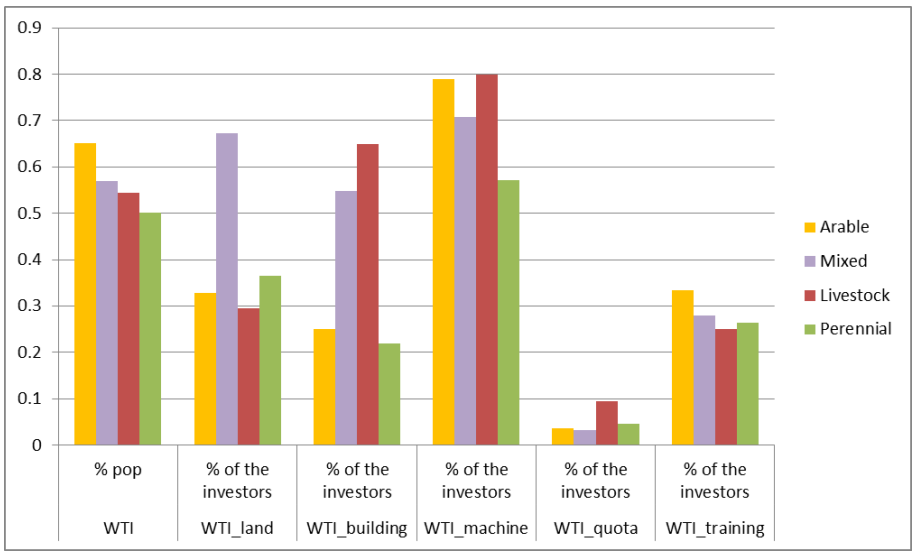
Figures and Tables

Figure 1: Profile of investors by farm type and farm size (weighted sample)





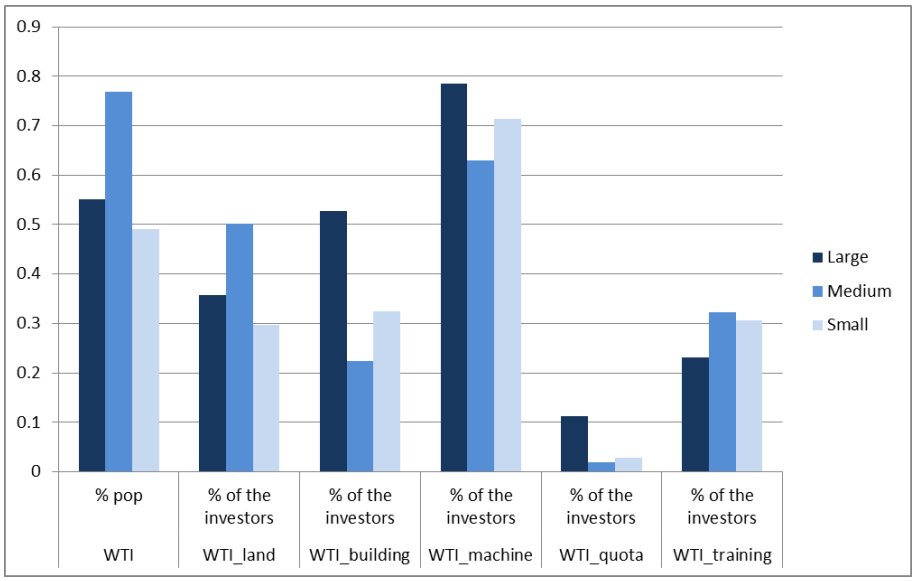


Table 1: Results of the factor analysis

Risk perceptions How likely are you to ever find yourself in each of the following situation?	Mean[a]	SD[a]	Risk Decreasing[b]	Risk Increasing[b]	
I sell my production on contract if it is possible	6	3	0.307		
I take out insurance for farm activities and holdings	7	3	0.509		
I have revenues coming from diverse activities on and off-farm	4	3			
I search for information and discuss with professional advisors before making decisions	7	2	0.559		
I test regularly my equipment to avoid breakdown	8	2	0.527		
I keep a written track of all what I produce, buy and sell	7	3	0.451		
I share thoughts about the business with family and getting them to support the work	8	2			
I work with an unbalanced crop rotation	4	3		0.158	
I have a high level of debts	4	3		0.748	
From time to time, I don't follow regulations	3	2			
I use short-term credit option in case of punctual money shortage	5	3		0.550	
I pay the bills with delay	4	3		0.525	
I participate to very few social activities with neighbours	5	3			
Environmental attitudes To what extent do you agree or disagree with the following statements?	Mean[a]	SD[a]	Sustainable farming actions[c]	Limited environmental consciousness[c]	No harming effects[c]
Agricultural activities today undermine the natural balance in the environment	4	3		-0.770	
Environmental problems resulting from agricultural activities are exaggerated by the media	7	2		0.774	
Commercial fertilizers and pesticides have no harmful effects; they promote high-quality production	6	2			0.866
Farmers are the best protectors of the natural environment, even if mistakes are made from time to time	8	2			0.606
I take some actions to protect the environment when managing my farm because I feel that I should	8	2	0.775		
I would pay more for environmentally friendly equipment and products	7	2	0.691		
It is important to have rules that impose farmers to reduce their environmental impact	7	2	0.696		

Note: Unweighted figures for risk, Weighted figures for environment and innovation
Note: Unweighted figures for risk, Weighted figures for environment and innovation
[a] Average and standard deviation results of a 1–10 Likert scale. Risk: ‘extremely unlikely’ (1) to ‘extremely likely‘(10); Environment and Innovation: 'extremely disagree' (1) to 'totally agree' (10).
[b] Factors: extracted from confirmatory factor analysis.
[c] Factors: extracted from exploratory factor analysis.

Table 1: Results of the factor analysis – following

Attitudes towards innovation To what extent do you agree or disagree with the following statements?	Mean[a]	SD[a]	Constant innovation [c]	Idea generation [c]	High-tech equipment [c]
New machinery/ideas in farming have improved upon traditional techniques	8	2	0.839		
It is important to keep up with new farming methods	8	2	0.762		
Modern record-keeping systems are important in farming	8	2	0.633		
I'll never leave my farm	7	3	0.472		
It is important to visit other farms to look at their methods	7	2		0.812	
I always have ideas on how to improve things	7	2		0.805	
I would describe my farming methods to be characteristically traditional rather than modern	6	2			-0.858
Compared to other farmers of my neighbourhood, I sue a lot of high technology products and machinery	6	2			0.732

Note: Unweighted figures for risk, Weighted figures for environment and innovation
[a] Average and standard deviation results of a 1–10 Likert scale. Risk: ‘extremely unlikely’ (1) to ‘extremely likely‘(10); Environment and Innovation: 'extremely disagree' (1) to 'totally agree' (10).
[b] Factors: extracted from confirmatory factor analysis.
[c] Factors: extracted from exploratory factor analysis.

Table 2: Results of cluster analysis – Mean scores

	Cluster 1 Involved-traditional farmers	Cluster 2 Indifferent farmers	Cluster 3 Entrepreneur farmers
N	40%	35%	25%
Risk_ Expected Benefits	7.36	5.90	7.93
Risk_ Perceived risk domains	2.60	3.95	6.58
Environment_ Sustainable Farming	7.71	6.24	8.14
Environment_ Limited environmental consciousness	5.39	5.61	6.07
Environment_ No Harming Effects	7.26	5.83	6.99
Innovation_ Constant Innovation	8.33	6.42	8.60
Innovation_ Idea Generation	8.28	5.95	8.23
Innovation_ High-Tech Equipment	5.71	5.80	5.98

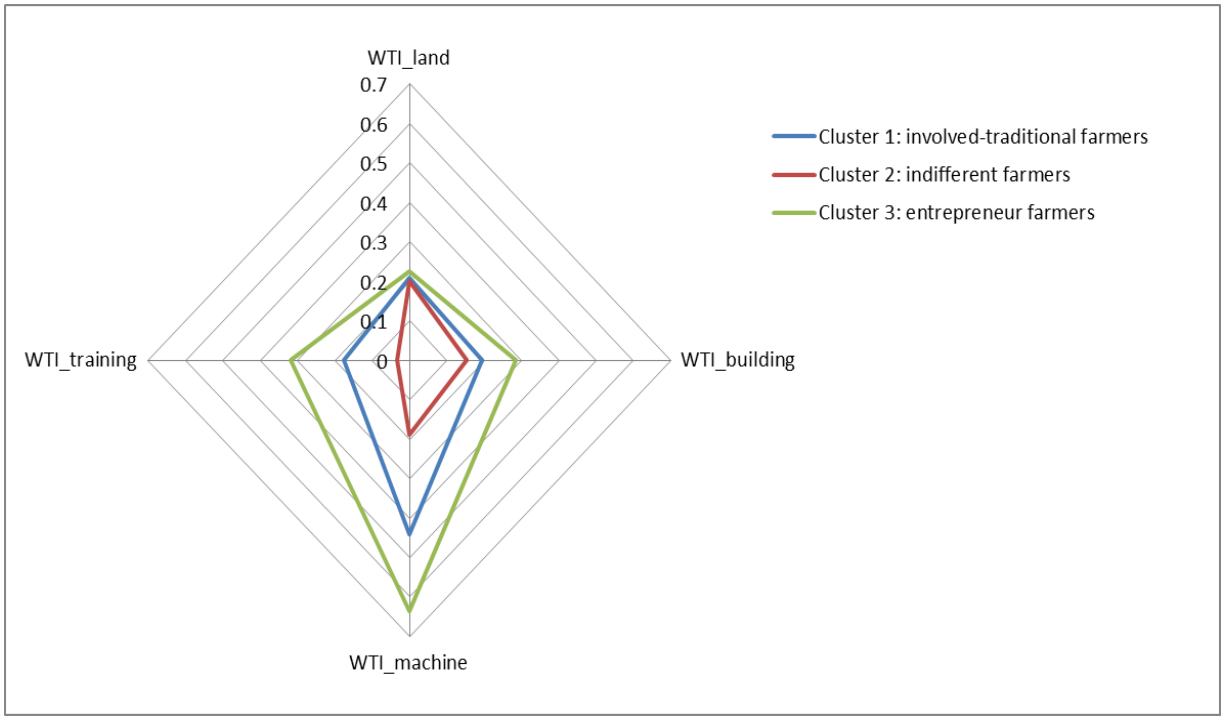
Note: Unweighted figures – Cluster analysis does not account for weighted data

Table 3: Descriptive statistics by cluster (weighted sample)

		Cluster 1	Cluster 2	Cluster 3
Specialization	Arable	33%	27%	32%
	Livestock	22%	18%	28%
	Perennial	34%	42%	30%
	Mixed	11%	13%	9%
Farm size	Small	47%	56%	41%
	Medium	22%	16%	22%
	Large	31%	28%	37%
Legal status	individual	90%	87%	87%
Country	CZ	0.6%	0.7%	0.3%*
	DE	16%*	9%	7%
	ES	32%	31%	30%
	FR	17%*	9%*	37%*
	IT	16%	31%*	16%
	PL	18%	18%	9%
Farmer characteristics	Birth year (average)	1964	1963*	1966
	Female	19%*	6%	6%
	Successor_no	44%	34%	37%

Note: * means that there is a significant difference at the 1% level between clusters (Pearson Chi2 test (weighted sample)/ ranksum test (unweighted sample))

Figure 2: Percentage of farmers willing to invest in each type of investment (% of the population)



Note: Weighted sample
Investments in quota and production rights are not graphically represented since they represent very few intentions to invest.

Table 4: Differences across clusters in willingness to invest

	Proportion of the farmers of the cluster having stated an intention to invest			Differences across clusters Pearson Chi2 (p-value)		
	Cluster 1	Cluster 2	Cluster 3	Diff 1-2	Diff 1-3	Diff 2-3
WTI	57.73% ^	42.23%	73.95%	(0.0537)*	(0.0522)*	(0.0008)***
WTI_land	20.84%	20.08%	22.47%	(0.9069)	(0.7869)	(0.7420)
WTI_machinery	44.01%	18.84%	63.56%	(0.0004)***	(0.0236)**	(0.000)***
WTI_building	19.46%	15.35%	28.41%	(0.4558)	(0.1409)	(0.0585)*
WTI_training	0.176%	0.0335%	0.3174%	(0.0008)***	(0.0756)*	(0.000)***
WTI_quota	0.0413%	0.0028%	0.0459%	(0.000)***	(0.8509)	(0.000)***

Note: The figure ^ should be understood as follows: 57.73% of the farmers of cluster 1 have an intention to invest

Table 5: Probit Willingness to invest by type of investment (svy: probit)

VARIABLES	(1) WTI_land	(2) WTI_building	(3) WTI_machine	(4) WTI_training
arable	-0.304	-0.349	0.482*	0.358
	(0.244)	(0.279)	(0.246)	(0.266)
livestock	-0.715***	0.299	-0.0593	0.159
	(0.250)	(0.290)	(0.252)	(0.335)
perennial	-0.322	-0.143	0.0591	0.272
	(0.270)	(0.303)	(0.267)	(0.309)
CZ	0.0230	0.292	0.0552	-0.327
	(0.260)	(0.267)	(0.273)	(0.316)
DE	-0.214	0.0388	0.327	-0.0537
	(0.275)	(0.266)	(0.285)	(0.332)
ES	-0.446*	-1.724***	-0.347	-0.626*
	(0.266)	(0.426)	(0.309)	(0.322)
FR	-0.556**	-0.0274	0.0163	-0.418
	(0.279)	(0.293)	(0.273)	(0.325)
IT	-0.669**	-0.318	-1.427***	-0.652**
	(0.300)	(0.314)	(0.283)	(0.323)
Small size	-0.415*	0.0330	-0.199	0.210
	(0.212)	(0.232)	(0.234)	(0.277)
Medium size	0.539**	0.0460	-0.0498	0.533*
	(0.250)	(0.245)	(0.230)	(0.295)
Individual farm	-0.0380	0.0490	0.291	-0.00312
	(0.293)	(0.235)	(0.241)	(0.314)
Birth date of the farm head	0.0225**	0.0133*	-0.000487	0.0119
	(0.00971)	(0.00799)	(0.00936)	(0.0132)
Female farm head	0.0172	-0.512*	-0.762***	-0.813*
	(0.302)	(0.277)	(0.278)	(0.438)
No successor at the moment	-0.160	-0.698***	-0.139	-0.592***
	(0.208)	(0.189)	(0.208)	(0.216)
cluster1	-0.0731	-0.298	-0.544**	-0.457*
	(0.217)	(0.211)	(0.225)	(0.254)
cluster2	-0.0270	-0.478**	-1.255***	-1.437***
	(0.266)	(0.236)	(0.257)	(0.348)
Constant	-43.97**	-25.98*	1.425	-23.69
	(19.18)	(15.76)	(18.42)	(26.07)
Obs	Sample=780 Population=1700000	Sample=780 Population=1700000	Sample=780 Population=1700000	Sample=780 Population=1700000
Goodness of fit	F(9,771)=1.21 Prob>F=0.2828	F(9,771) =16.80 Prob>F=0.0000	F(9,771)=1.01 Prob>F=0.4287	F(9,771) =0.94 Prob>F=0.4885

Note: Weighted sample

Table 6: Multivariate probit Willingness to invest in the different types of investments

	(1)	(2)	(3)	(4)
VARIABLES	WTI_land	WTI_building	WTI_machine	WTI_training
arable	0.188	-0.349**	0.295**	0.356**
	(0.142)	(0.145)	(0.135)	(0.156)
livestock	-0.0804	-0.114	-0.110	-0.121
	(0.149)	(0.146)	(0.139)	(0.169)
perennial	-0.134	-0.176	-0.0742	-0.0864
	(0.150)	(0.148)	(0.140)	(0.170)
CZ	0.0721	0.0692	-0.0285	-0.0211
	(0.167)	(0.166)	(0.164)	(0.200)
DE	-0.393**	-0.0353	0.0867	0.370**
	(0.163)	(0.161)	(0.159)	(0.178)
ES	-0.701***	-1.380***	-0.577***	-0.789***
	(0.186)	(0.235)	(0.170)	(0.264)
FR	-0.561***	-0.360**	-0.0427	0.0904
	(0.178)	(0.171)	(0.168)	(0.191)
IT	-0.689***	-0.561***	-0.895***	-0.124
	(0.185)	(0.177)	(0.175)	(0.206)
Small size	-0.341**	-0.239*	-0.304**	-0.120
	(0.141)	(0.140)	(0.129)	(0.157)
Medium size	0.0194	-0.145	-0.188	0.00730
	(0.142)	(0.146)	(0.137)	(0.160)
Individual farm	-0.0369	-0.268*	-0.163	-0.325**
	(0.143)	(0.140)	(0.135)	(0.156)
Birth date of the farm head	0.0188***	0.0185***	0.0108**	0.00899*
	(0.00485)	(0.00485)	(0.00452)	(0.00537)
Female farm head	-0.241	-0.227	-0.482***	-0.212
	(0.177)	(0.177)	(0.165)	(0.208)
No successor at the moment	-0.293**	-0.478***	-0.0326	-0.100
	(0.115)	(0.116)	(0.104)	(0.126)
cluster1	-0.0360	-0.276**	-0.240**	-0.0701
	(0.127)	(0.127)	(0.121)	(0.133)
cluster2	-0.292*	-0.388***	-0.665***	-0.667***
	(0.149)	(0.149)	(0.138)	(0.177)
Constant	-36.84***	-35.73***	-20.58**	-18.17*
	(9.539)	(9.539)	(8.896)	(10.55)
Obs	780	780	780	780
Rho21	0.356***			
Rho31	0.424***			
Rho41	0.296***			
Rho32	0.428***			
Rho42	0.451***			
Rho43	0.563***			
Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0: chi2(6) = 191.263 Prob > chi2 = 0.0000				

Note: Unweighted sample