EU farmers' intentions to invest in 2014-2020: complementarity between asset classes

M. Lefebvre[1], S. Gomez y Paloma[1], D. Viaggi[2]

Corresponding author: Marianne.Lefebvre@ec.europa.eu

[1] European Commission, Joint Research Centre (JRC), Institute for Prospective Technological Studies (IPTS), Agrilife Unit, Edificio Expo. c/ Inca Garcilaso, 3, 41092 Seville, Spain

[2] Department of Agricultural Sciences, University of Bologna, Italy

Paper prepared for presentation at the EAAE 2014 Congress
'Agri-Food and Rural Innovations for Healthier Societies'

August 26 to 29, 2014
Ljubljana, Slovenia

Abstract: This article aims to analyse the determinants of EU farmers' intentions to invest in the period 2014-2020. It analysed data of a survey of 780 farmers interviewed in spring 2013, covering 6 EU countries (Czech Republic, Germany, Spain, France, Italy, Poland) and four different farm types (arable crops, livestock, perennial crops and mixed farms). A multivariate probit model is used in order to determine the factors explaining the willingness to invest or not to invest in various farm asset classes (land, building, machinery, training) by the surveyed farmers. The multivariate probit allows taking into account the possibility of simultaneous investments and the potential correlations among these investment decisions. We find that investments in different asset classes are complementary. Farmers willing to invest in one asset class are also willing to invest in other asset classes, after controlling for observable characteristics such as farm size, specialization, farmer's age. This paper contributes to the limited literature on farmers' investment decisions at EU-level. Future versions of the paper will include the marginal effects, as well as improved justification of the methodology and interpretation of the results.

JEL code: Q12

Keywords: Investment, Agriculture, Willingness to invest, EU, multivariate probit

Acknowledgments: The survey on which this paper is based was funded by the IPTS, JRC-European Commission in the context of the project "Survey and Data analysis on EU farmers expected investment decisions and their determinants", Contract 153025-2012 A08-BE. However, the views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission. The authors would like to thank Mercedes Obra (GfK Spain), Joke Wiercx, Kim De Cuyper, Ellen Loix (GfK Belgium) for organizing data collection.

I. Introduction

In general, firm's investment behaviour represents their capital stock adjustments as a response to market opportunities and competitive pressures. Particularly in agriculture, factors such as family traditions, attachment to land and substitutability and complementarity of production factors influence decisions on physical capital adjustments (Kataria, Curtiss et al. 2012). The successful formulation of agricultural policies fostering investments requires in-depth understanding of the socio-economic factors underlying and directing farmer's incentives and behaviours. We analyse EU farmers' intentions to invest in land, machinery, building and training during the next Common Agricultural Policy programming period (2014-2020), on the basis of survey data collected in 6 EU countries in spring 2013.

The contribution of this study is threefold. First, the survey provides *ex ante* data on investments likely to be realised in the period 2014-2020, while most studies focus on the determinants of investments already realised (Buysse, Verspecht et al. 2011; Esposti 2011; Ferto, Bakucks et al. 2011; Kirchweger, Eder et al. 2011; Vesterlund Olsen and Lund 2011). Second, the survey covers intentions to invest in various on-farm asset classes (land, machinery and equipment, buildings, training), as well as on farms and farmers' characteristics. Last, and to the best of our knowledge, the study presented here is one of the very few cross-country and cross-farm specialisation studies on on-farm investment. Most studies on the determinants of farmers' investment decisions have focused on one country and/or on one farm specialisation (Oude Lansink, Verstegen et al. 2001; Gardebroek and Oude Lansink 2004; Oskam, Goncharova et al. 2009; Vesterlund Olsen and Lund 2011; Sauer and Zilberman 2012; Fałkowski 2013). Guastella et al. (2013) conducted a multi-country study (France, Germany, Hungary, Italy and United Kingdom) on investment demand for farm buildings and machinery and equipment, but restricted this to specialised arable crop farms. A recent survey does provide recent and multi-country data on farmers' intentions to invest (DLG Trend monitor Europe 2013). This survey has the advantage of being updated twice a year and covers a large sample of 2350 farmers. However the sample is biased towards large 'business-minded' farmers in Europe, and is restricted to four countries (Germany, Poland, France and United Kingdom). While our sample, albeit limited to 780 farms, contributes to the understanding of EU farmers decisions in a broader and more diverse range of farms and farmers' situations.

The paper is structured as follows. Section II presents the data and method. Results are presented in section III. Section IV provides conclusive remarks.

II. Material and method

1. Survey design

The data were collected in spring 2013, through face-to-face interviews. The survey covers 780 farm-households in six EU countries (Czech Republic, Germany, Spain, France, Italy and Poland), four different farm specialisations (arable crops, livestock, perennial crops and mixed farms)[1], as well as different farm sizes.

[1] The four main farm specialisations selected represent combination of several types of farming in the community typology (REG 85/377/EEC). Farms are classified as specialized in livestock if at least 66% of their overall income comes from livestock production (the same applies for arable and perennial specialisation), while mixed farms have at least 33% of their income coming from crop production and 33% from livestock production.

The six countries were selected for the diversity of their agro-climatic conditions, farm structures and implementation modes of the Common Agricultural Policy (Single Farm payments in Germany, Spain, France, Italy vs Single Area Payment Scheme in Czech Republic and Poland). These six countries host 40% of the EU28 farm holdings and represent 57% of total UAA.

The methodology selected to analyse the farm investment foreseen in 2014-2020 involved development of an 'intention survey', as previous empirical research has shown that 'stated intentions' are a reasonably good approximation of 'realised actions' in the case of farm investments (Lefebvre, Raggi et al. 2013). Moreover, intention surveys offer other advantages, such as revealing a farmer's frame of mind and expectations about the evolution of their environment and their business confidence, which are otherwise difficult to capture.

2. Sampling

A cluster-sampling procedure was used to select the farms. Three to four NUTS2 regions were selected per farm specialisation in each of the six countries. Regions were selected on the basis of being areas in which a particular farm specialization is well represented. The selection of regions for each country and farm specialisation involved three steps: (1) First, regions were ranked according to the value of four indicators: the number of holdings, the utilised agricultural area in hectares or the number of livestock units for livestock farms, the economic importance of each farming type in that region in terms of standard output (€) and agricultural labour, according to Farm Structure Survey 2007 data; (2) The rankings of the four indicators were then combined, resulting in an overall ranking; (3) The four regions with the highest overall ranking were selected (except in the case of Czech Republic, where the top three were selected). We can verify that, for each country and farm specialisation, the selected regions cover at least 40% of the national UAA of this farm specialisation. The sample was then selected at random, within those regional farm type cells, from a list of farms developed by the survey company. Soft quotas applied in order to achieve a reasonable distribution of farms selected by farm size.

While the sample is too small to be representative of EU farming, it covers a large range of farming systems and agro-climatic conditions. The sample is almost equally divided over the different farm specialisations (201 arable farms, 202 livestock farms, 183 perennial farms and 194 mixed crop farms). The sample is biased toward larger farms and younger farmers compared to the actual general farm population of the six countries covered by the study. This study can be seen to focus on the more active farmers, as these are more likely to have interesting investment behaviours. The interested reader can find more information on the number of farmers interviewed by region and farm specialisation, as well as the characteristics of the sample in the report (Lefebvre, De Cuyper et al. 2014).

3. Questionnaire

Farmers were asked whether or not they intended to invest in the period 2014-2020, corresponding to the next CAP programming period. Intentions to invest were detailed according to the category (land, buildings, machinery and equipment, training) and nature of the investment, investment value, planned date for investment, ways of financing this investment, and the reasons for investing or not investing. This enables a full understanding of farmer investment intentions, according to the nature of the assets, costs and expected benefits.

The survey focuses on physical on-farm investment (land, buildings, machinery and equipment) and investments in training. Land is a peculiar asset in farming, as it covers most of the value to farms (except for some livestock farms with animal indoors and little land).

The investment in land depends on diverse and complex factors, such as competition for land use, speculative forces in the land market, the design of the agricultural policy, etc. (Ciaian, Kancs et al. 2012). Farmers operating family farms may also have individual or personal reasons to sell or keep their land, including family traditions, prestige, and lifestyle values. In building-intensive systems (e.g. livestock farming), buildings may be highly demanding in terms of investment. Barns, silos and different type of storage provide examples of agricultural buildings. Examples of farm machinery include tractors, ploughs and combines, while equipment include milking machines and fences. An important part of innovation in farming is related to the adoption of advanced technology, often embodied in new machinery and equipment. Human capital and investments in training are recognised are very important in modern farming. "Fostering lifelong learning and vocational training in the agricultural and forestry sectors" is for example one of the six Union priorities for rural development (EU 2013). Given that the main objective of the survey is to analyse farm investment, we only collected information on training paid for by the farmer. We therefore do not have an accurate overall picture on the amount of training received by the farmers; which might include training offered for free to the farmers from extension services, cooperatives and input suppliers.

4. Research hypotheses

According to neo-classical economic theory, a new investment is realized when the sum of the discounted expected benefits over the life of the equipment are higher than the investment costs. Variables capturing general farm and farmers' characteristics are useful to explain investment decisions. These variables are assumed to affect both the subjective evaluation of the future returns from investment (both in monetary and non-monetary terms) and resource availability to finance the investment. Theory of planned behaviour assumes that people's behaviour originates from their intentions to perform a specific behaviour (Ajzen 1991). Therefore, we assume that the drivers of investment decisions are the same as the drivers of investment intentions. Moreover, we analyse the possibility of simultaneous investment and the potential correlation between the different decisions. Prior literature provides a basis for formulating a set of hypotheses on the influence of various factors of farm structure and socio-demographic characteristics on the decisions (and therefore the intentions) to invest. Table 1 provides a basic summary of findings from the literature in terms of empirical importance of a set of factors on farm investment behaviour. These factors are introduced in the model as explanatory variables.

Table 1: Evidence from the literature on the factors affecting on-farm investment intentions

	Evidence from the literature	Variable
Farm structure		
Farm size	Farmers operating large farms are more likely to have a larger asset base from which to draw resources to invest. Because of economies of scale, investments are more profitable on large than on small farms. This holds in particular for investments that are independent of farm size like training. Consequently, larger farms can generate higher net returns to such capital goods and therefore will invest more frequently. Larger farms also benefit from better managerial capacities, which can affect willingness to innovate and risk attitudes. However, decreasing marginal benefits associated with increasing size may restrain very large farms from further investments in land or buildings. Land being highly complementary with capital, larger farms invest more in machinery.	Logsizeunit= Log(UAA) for arable, perennial specialized arms and mixed farms or log (LSU) for livestock farms
Farm specialization	Farm specialization influences the type of assets farmers most need. Livestock farmers are more likely to be willing to invest	Mixed=1 for farms with at least 33% of their

	in buildings, while arable farmers are more likely to be willing to invest in land. Revenues generated by the farming activity also differ according to the type of specialization and therefore influences the potential return from investment.	income coming from crop production and 33% from livestock production. Livestock=1 for farms with at least 66% of their overall income comes from livestock production Permanent=1 for farms with at least 66% of their overall income comes from permanent crop production
Legal status	Individual farmers have more room for manoeuvre in their decision-making than farm holdings with several partners, but can also face greater financial constraints. The overall effect of being an individual farmer on investment is therefore ambiguous.	Individual=1 if the legal status of the farm is individual farm
Location	Farm location impact potential return from investment and therefore willingness to invest through differences in agricultural productivity, climate and farm-gate price from agricultural production. We separate location in plain, hill and mountain area (>300m above sea level).	Hill=1 if the farm is located in a hilly area below 300m above sea level Mountain=1 if the farm is located in a mountainous area above 300m above sea level
Labour	The impact of labour input on investment is expected to depend on the nature of the investment. Investments in machinery can allow to reduce labour, especially in more capital-intensive farming systems (eg. arable crops or intensive livestock). However, in small farms and labour-intensive production systems (eg. perennial crops), the production process does not allow such substitution between labour and machinery. Investments in training are expected to be positively correlated with labour quantity since it aims at increasing human capital. No specific impact of labour quantity on investments in land and buildings is expected. (Gardebroek and Oude Lansink 2004)	Permanentworker = number of permanent workers on the farm
Rented land	Farmers with a larger proportion of owned acres are more likely to be willing to invest in general, since owning land provides greater wealth, greater stability and a larger asset base (Elhorst 1993). The ratio of tenanted land to total land farmed reflects the amount and quality of collateral available (Benjamin and Phimister 2002). However, farmers renting the majority of their cultivated land may be willing to increase the share of owned land and therefore be willing to invest in land.	Sharerentedland= Share of rented land over total UAA
Existing assets	Investments realized in the past constitute the existing capital stock. Farmers having invested recently may therefore not need to invest in new assets and or not have the financial situation to do so. On the other hand, existing assets can constitute the collateral requested by the bank, when asymmetric information in capital markets means that banks base their lending decisions on factors such as available collateral rather than projected profitability. Therefore having a large asset base can favour investment. Moreover, farm strategic development tends to be path dependent and past investments can influence the extent of future investments. More specifically, the availability of some assets tends to encourage further investment in other assets while discouraging investment in the widely available capital good.	land20082012_D=1 if the farmer has invested in land between 2008 and 2012. bulding20082012_D=1 if the farmer has invested in building between 2008 and 2012. machine20082012_D=1 if the farmer has invested in machinery and equipment between 2008 and 2012. training20082012_D=1

	(Elhorst 1993) (Vesterlund Olsen and Lund 2011)	if the farmer has invested in training between 2008 and 2012.
Farmer's sociodemographic characteristics		
Age	The stage of the farm household life cycle, often approximated as the owner's age, is likely to influence intentions to invest. Older farmers may not wish to farm as actively as younger farmers and therefore invest less. Compared to older farmers, it is hypothesized that younger farmers are more willing to expand their operations. But younger farmers may not be able to invest because of inexperience or financial constraints. Non-linearities are usually expected in the age-investment relationship. (Gardebroek and Oude Lansink 2004) (Weiss 1998) (Oude Lansink, Verstegen et al. 2001)	Age=Age of the farm head
Succession	Willingness to invest is impacted by the farm head's expectations regarding the continuation of farming activity. The presence of successor holds farmers back from dis-investing so that the successor can take over the farm (Calus, Van Huylenbroeck et al. 2008). Reverse causality is also true since the theory of asset fixity and transaction cost theory explain why higher total farm assets should result in a higher intention to transfer the farm to the next generation. If the successor is a family member, incentives to invest are stronger.	Successor_no=1 if no successor has been identified
Education	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. Higher education can favour decision planning, therefore impacting on the intention to invest (Gardebroek and Oude Lansink 2004).	Education=variable between 1 to 6 representing level of education of the farm head(1=no or primary only, 6=tertiary education)
Diversification of farmers' activities on or outside the farm	Previous empirical studies of farm investment have found statistically significant relationships between farm investment and the existence of other income-generating activities on or outside the farm, albeit there is no consistency in the direction of the relationship. On the one hand, economic theory suggests that it may be rational for part-time farmers to substitute capital for labour, thereby releasing labour for off-farm work while still maintaining farm output. Empirical evidence support this substitution effect, with significant positive relationships found between farm growth and off-farm income, suggesting that farms with higher levels of off-farm income are more likely to grow their farms through investment. Moreover, stable off-farm incomes can relax the financial constraints to investing in farm capital. On the other hand, off-farm activities reduce the time dedicated to the farm, and therefore can discourage expansion of the farm business in terms of farming activities and can encourage an increase in investment in non-farm assets relative to farm assets The transition from full-time to part-time farming can often be perceived as a first step out of farming, and therefore farmers that work off the farm might not be expected to reinvest in farming. Farmers that work off the farm may also have lower expectations of continuing the farm business, and be less likely to have a successor, and as a consequence may be less likely to invest in their farms Moreover, when part-time farmers operate more extensive and less profitable farms, lower rates of returns will further discourage investment. (Upton and Haworth 1987) (Weiss 1997)	offfarmhead_D=1 if the farm head as a remunerated professional activity outside the farm onfarmother_D=1 if the farm is diversified with non-farming activities on the farm (tourism, processing of farm products, energy production ..)

	(Hennessy and O' Brien 2008) (Andersson, Ramaswami et al. 2005) (Rosenzweig and Wolpin 1993). (Glauben, Tietje et al. 2004). (Harris, Blank et al. 2010).	
External economic conditions		
Interest rate	Interest rates have significant impacts on the agricultural industry by affecting the cost of borrowing money, investment decisions and values of farmland (Myyra 2013).	r= real interest rates at national level, equal to the average yields for ten years long-term government bonds in year 2013 minus the inflation rate (average rate of change in the Harmonised Indices of Consumer Prices), both from Eurostat.
Growth rate	A farmer's decisions about investment are likely to be affected by subjective beliefs and probabilities for project returns. Economic growth rate is used as a proxy for favourable economic conditions and positive expectations on return from investment. Evidence exists that investment sensitivity to cashflow is increased during recessions and in the recovery period relative to when economic conditions are more buoyant (Bierlen, Ahrendsen et al. 1998).	Growthrate= real GDP growth rate between 2012 and 2013, according to Eurostat
Regulation of land market	Land regulations affect property rights, tenure security and access to land for farmers, as well as the distribution of economic rents and policy rents when farmland values are impacted by regulation. More regulation often means higher transaction costs associated to land purchase and this can impact intentions to invest. As a result, regulation impacts the therefore the trade-off between renting or buying land. Despite the EU single market and the CAP, the diversity in land markets and their governance among EU Member States is remarkable (e.g. land prices and rental contracts are regulated by the government only in some countries) (Swinnen, Van Herck et al. 2013).	TRI= total regulatory index, which is a measure of the total amount of regulations in the land market. The index accounts for (1) measures to protect the tenant, (2)measures to protect the owner-cultivator, (3) measures to protect the owner, and (4) measures to prevent land fragmentation.

5. Econometric model

This section describes the econometric approach to obtain estimates of the effect of various variables on investment intentions by European farmers. Most previous studies on farm investment analyse factors influencing one type of investment only (land, or machinery most often), rather than considering the possibility of simultaneous investment and the potential correlation between the different decisions. Our database offers the opportunity to examine the drivers of investments in land, building, machinery and equipment and training, while taking into account the possibility of simultaneous investments.

The empirical model chosen is the multivariate probit (MVP). The MVP allows for the possible correlation in the different decisions. This specification is useful since we do not observe how the different investment decisions interact to affect the net return of the farmer, and these effects are therefore subsumed in the error terms. Moreover, unobservable individual heterogeneity (risk aversion, ability …) can influence at the same time two of the investment decisions made by the respondent.

The model is specified as a system of four equations, with Y_1 the intention to invest in land, Y_2 the intention to invest in building, Y_3 the intention to invest in machinery and equipment and Y_4 in training.

$$Y_{ij}^{*} = \beta_j X_{ij} + \varepsilon_{ij},\ j=1,\ldots,4$$

$$Y_{ij} = 1 \text{ if } Y_{ij}^{*} > 0, \text{ and 0 otherwise}$$

$$\varepsilon_{ij} \sim N_j [0,R],\ j=1,\ldots,4$$

where Y_{ij} represents the intention to invest in the asset class j by the farmer i. X_{ij} is a vector of observed variables of farmer i that affects the investment intention j. We use the same set of explanatory variables for all equations ($X_{ij}= X_i$). The error terms are distributed as multivariate normal, each with a mean of zero, and variance-covariance matrix R, with 1 on the main diagonal values and correlations $\rho_{jk}= \rho_{kj}$ in off-diagonal values.

The system of equations is estimated using the mprobit program in NLOGIT 4.0. 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 choices the researcher must make is about the number of draws to consider. The maximum simulated likelihood estimator is asymptotically equivalent to the true maximum likelihood estimator as the ratio of the square root of the sample size to the number of draws tends to zero. For moderate to large sample sizes, setting the number of draws 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 28 draws. There were only small differences in the results under alternative choices of the number of draws.

III. Results

We present the results of the different models and analyse the determinants of investment intentions. The parameter estimates from the multivariate probit are presented in table 3, while results of the individual probits are presented in table 4 for comparison.

Overall, in the full sample of 780 farmers, it was found that 61% of farmers are willing to invest in the period 2014-2020. While 21% of the farmers plan to invest in only one asset class, 40% are willing to invest in several asset classes. Only 4% are willing to invest in the four types of capital. Overall, 47% of investors planned to invest in machinery and equipment, while investments intentions in land, buildings, training are less frequent (27% land, 31% buildings, 16% training). These numbers hide high heterogeneity across countries and farm specialization. While more than 70% of the polish and German farmers are willing to invest, less than 40% of the Italian and Spanish are willing to do so. Farms specialized in arable crops represent the more important investors in land (29% of the intentions to invest), machinery (30%) and training (36%), while livestock farms are the main investors in building (30%). Half of the farmers willing to invest in land plan to buy less than 10.5 hectares (median), and one quarter even plan to by less than 5 hectares. 16.9% of the farmers declare they will buy more than 50 hectares of land over the period. Investments in buildings concern mainly animal housing, followed by machine and crop storage. Tractors rank first in the intentions to invest in machinery, followed by sprayer. The training courses envisaged by the farmers have highly diverse content but farm management, crop protection and production methods in general have the highest ranks.

1. Correlation between the different intentions to invest

In order to get first insights on the relationship between the different investment intentions, we use Pearson Chi-squared tests (Table 2). The tests confirm the existence of strong correlation between the decisions to invest in the different assets (significant at the 1% level for all pairwise combinations). Overall, these tests suggest that it is important to take into account the possibility of simultaneous intention to invest in various asset classes when analysing the determinants of these decisions. Moreover, in the multivariate probit model, we observe that the pairwise correlation coefficients ρ_{ij} are all positive and significantly different from zero (Table 3). These coefficients measure the correlation between the intentions to invest in the four asset classes, after the influence of the observed factors has been accounted for. This supports our hypothesis that the error terms are correlated, and a multivariate probit approach is appropriate.

The positive signs of the correlation coefficient suggest that a farmer intending to invest in one type of asset is more likely to intend to invest in other asset classes and vice-versa. Unfortunately, our results do not allow distinguishing whether the positive correlation observed is due to complementarities between the different assets, or other unobserved characteristics related to the farmer (risk aversion, ability), the production or the local context.

We also observe that farmers having invested in the period 2008-2012 in at least one of the assets are also more likely to invest, both in the same asset class, and other assets. It suggests there is both inter- and intra-temporal complementarities between investments.

Table 2: Number of farmers intending to invest in the different assets

Intention to invest in	Land	Building	Machinery	Training	
Land		113 Phi=0.2993 Pr=0.00	152 Phi=0.3096 Pr=0.00	55 Phi=0.1778 Pr=0.00	209
Building			174 Phi=0.3291 Pr=0.00	69 Phi=0.2362 Pr=0.00	243
Machinery				107 Phi=0.3496 Pr=0.00	368
Training					122

2. The determinants of investment intention

The interpretation of the drivers of investment intentions is made on the basis of the results of the MVP. The signs and significant variables in the multivariate and individual probit approaches are largely similar. In next versions of the paper, interpretation will be based on marginal effects calculated as the impact of an explanatory variable on the probability of intending to invest in asset class j (Y_j =1), conditional also intending to invest in the other asset classes (Y_{-j}=1).

We measure farm size as the number of hectares or number of livestock unit for farms specialized in livestock. We find that farmers operating large farms are more likely to have stated an intention to invest in machinery, but the effect is non-linear (log). Land being highly

complementary with physical capital, larger farms invest more in machinery. Controlling for farm size, the legal status (individual or partnership) has no significant impact.

We compare the willingness to invest of the farmers according to their farm specialization, taken as reference arable farms. We find that farms with livestock (specialized in livestock or mixed farms) are more likely to intend to invest in buildings, for example for animal housing. Mixed and livestock farms are also significantly less likely to invest in machinery and training. Being located in hill and mountain areas has no significant impact on intentions to invest.

We observe that the impact of the number of full-time workers on the farm on investment depends on the nature of the investment. The impact is significant and positive for intentions to invest in land and building, suggesting complementarity between labour and capital.

Farms with a higher share of rented land in the total area cultivated are more likely to intend to invest in land and building. It suggests that farmers are willing to farm their own land. While tenant farmers may have more difficulties in getting access to credit, this does not reduce their intention to invest. Analysing realized investments rather than intentions may lead to opposite results.

The coefficients of the farmer socio-demographic variables have the expected signs. Older farmers are less likely to intend to invest, especially in land and buildings. The impact of age on the intentions to invest is not surprisingly more important for assets with longer lifespan. The same result holds for the absence of a successor. Farmers with no successor identified at the time of the survey are less likely to intend to invest in land and building. They are also less likely to invest in training. Given that human capital is more difficult to transfer to the next generation, we have no clear explanation for that.

We confirm that farmers having received more education are more likely to have stated an intention to invest. This can be due to the fact that education favours decision planning. The result is significant for land and machinery only. This may be due to the fact that investments in buildings are often driven by the need to comply with regulation (eg. animal welfare) and therefore less driven by strategic planning.

We do not find any significant impact of diversification of farmer' activities (both on and off farm) on intention to invest. We only observe that off-farm labour discourage investment in training. It suggests that motivational aspects are important in accumulation of human capital: the lower the time dedicated to the farm, the less the farmer is motivated by learning and modifying his farming practices, and the less likely he is to be willing to invest in training.

The external economic forces have the expected impact. In those countries were economic growth was higher in 2013, farmers are more likely to intend to invest in all assets but training. The impact of the real interest rate appears significant only for the land market. We observe that where real interest rates are higher (around 3% in Spain, Italy and Poland), farmers are more likely to intend to invest in land. This is consistent with real options models, where investment can increase when interest rates rise under the condition that growth rates are high or uncertainty is high (Capozza and Yuming 2001). These conditions hold only in the case of Poland (1.6% growth rate, whereas Spain and Italy faced a negative growth rate in 2013) and we indeed observe that intentions to invest in land are the highest in Poland. We observe a significant impact of land regulation on intentions to invest in land. In countries were the total regulatory index is high (France, Poland, Italy), the transaction costs associated to investments are likely to be higher and, as expected, we observe that farmers are less intending to invest in land.

Last but not least, we confirm that farm investment strategies tends to be path dependent given that having realized an investment recently (in the period 2008-2012) positively and significantly explain the intention to invest in the period 2014-2020. Surprisingly, this result is observed even in the same asset class. We could have expected that the farmers having realized recently costly investments in land and building are not likely to invest again in the same asset class, but we observe an opposite result. We also observe positive signs in the off-diagonal (e.g. there is a positive impact of past investments in land on the intention to invest in building).

IV. Discussion and conclusion

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 more than sixty percent of the surveyed farmers are willing to invest in at least land, building, machinery or training between 2014 and 2020. The determinants of farmers' intentions to invest have been tested using a multivariate probit model, which allows taking into account the possibility of simultaneous investments and the potential correlations among these investment decisions. After having validated this econometric approach, we have found that investments in each asset classes are complementary. Farmers willing to invest in one asset class are also willing to invest in other asset classes, after controlling for observable characteristics such as farm size, specialization, farmer's age… Future versions of the paper will include the marginal effects, as well as improved justification of the methodology and interpretation of the results.

Table 3: Multivariate probit Willingness to invest in the different types of investments

VARIABLES	(1) WTI_land	(2) WTI_building	(3) WTI_machine	(4) WTI_training
logsizeunit	0.0368	-0.0355	0.0899*	-0.0418
	(0.0519)	(0.0503)	(0.0475)	(0.0600)
mixed	-0.113	0.275*	-0.307**	-0.517***
	(0.149)	(0.147)	(0.138)	(0.174)
livestock	-0.0897	0.353**	-0.259*	-0.340*
	(0.149)	(0.149)	(0.140)	(0.175)
perennial	0.0654	0.197	-0.0292	-0.470**
	(0.182)	(0.180)	(0.165)	(0.217)
individual	0.0806	-0.0269	-0.00446	0.211
	(0.157)	(0.148)	(0.145)	(0.175)
permanentworker	0.00710*	0.0155***	-0.00181	0.00411
	(0.00414)	(0.00495)	(0.00382)	(0.00403)
sharerentedland	0.581***	-0.0813	0.383**	0.108
	(0.174)	(0.170)	(0.158)	(0.201)
mountain	0.149	0.194	0.173	-0.140
	(0.183)	(0.178)	(0.173)	(0.222)
hill	0.0783	0.0398	0.155	-0.281
	(0.134)	(0.131)	(0.124)	(0.171)
education	0.115*	0.0606	0.112*	0.122
	(0.0695)	(0.0715)	(0.0656)	(0.0817)
age	-0.0154***	-0.0156***	-0.00309	0.00488
	(0.00508)	(0.00501)	(0.00468)	(0.00616)
successor_no	-0.332***	-0.519***	-0.00466	-0.249*
	(0.117)	(0.117)	(0.105)	(0.142)
onfarmother_D	-0.178	0.137	0.208	-0.0680
	(0.140)	(0.130)	(0.127)	(0.158)
offfarmhead_D	0.217	-0.00890	0.0451	-0.386**
	(0.141)	(0.141)	(0.134)	(0.176)
r	12.72**	-7.384	-2.520	-7.698
	(5.279)	(4.954)	(4.596)	(6.031)
growthrate	0.148***	0.148***	0.198***	0.0735
	(0.0519)	(0.0475)	(0.0448)	(0.0587)
land20082012_D	0.688***	0.332***	0.108	0.202
	(0.123)	(0.121)	(0.120)	(0.142)
building20082012_D	-0.0471	0.397***	0.0210	0.0600
	(0.116)	(0.111)	(0.110)	(0.134)
machine20082012_D	0.341**	0.272**	0.421***	0.289*
	(0.142)	(0.138)	(0.124)	(0.174)
training20082012_D	0.126	0.282**	0.480***	1.393***
	(0.116)	(0.114)	(0.111)	(0.139)
TRI	-0.0479**			
	(0.0217)			
Constant	-0.998**	-0.231	-1.075**	-1.859***
	(0.485)	(0.472)	(0.437)	(0.575)
Observations	780	780	780	780
% correctly classidied (all)	76	74	69	85
% correctly classidied (WTI=1)	30	38	66	25
% correctly classidied (WTI=0)	94	90	71	96

atrho21	atrho31	atrho41	atrho32	atrho42	atrho43
0.390***	0.409***	0.282***	0.402***	0.392***	0.684***
(0.0725)	(0.0704)	(0.0851)	(0.0713)	(0.0847)	(0.0999)

Table 4: Individual probit Willingness to invest in the different types of investments

VARIABLES	(1) WTI_land	(2) WTI_building	(3) WTI_machine	(4) WTI_training
logsizeunit	0.0370	-0.0384	0.0903*	-0.0508
	(0.0520)	(0.0502)	(0.0479)	(0.0613)
mixed	-0.109	0.324**	-0.308**	-0.507***
	(0.149)	(0.148)	(0.139)	(0.178)
livestock	-0.0685	0.394***	-0.260*	-0.330*
	(0.149)	(0.150)	(0.140)	(0.179)
perennial	0.0564	0.223	-0.0497	-0.465**
	(0.183)	(0.180)	(0.167)	(0.220)
individual	0.0723	-0.0455	0.00613	0.207
	(0.157)	(0.150)	(0.145)	(0.180)
permanentworker	0.00709*	0.0146***	-0.00149	0.00309
	(0.00403)	(0.00482)	(0.00390)	(0.00417)
sharerentedland	0.582***	-0.0401	0.395**	0.0858
	(0.174)	(0.170)	(0.158)	(0.205)
mountain	0.187	0.215	0.175	-0.0671
	(0.180)	(0.176)	(0.173)	(0.227)
hill	0.0765	0.0335	0.159	-0.245
	(0.135)	(0.132)	(0.125)	(0.176)
education	0.0992	0.0426	0.107	0.126
	(0.0701)	(0.0723)	(0.0662)	(0.0842)
age	-0.0156***	-0.0162***	-0.00357	0.00366
	(0.00508)	(0.00502)	(0.00471)	(0.00631)
successor_no	-0.333***	-0.524***	-0.0103	-0.252*
	(0.118)	(0.117)	(0.105)	(0.144)
onfarmother_D	-0.174	0.158	0.243*	-0.0755
	(0.141)	(0.132)	(0.129)	(0.163)
offfarmhead_D	0.212	0.00664	0.0483	-0.364**
	(0.142)	(0.141)	(0.135)	(0.181)
r	12.17**	-7.891	-2.664	-6.357
	(5.316)	(4.984)	(4.640)	(6.142)
growthrate	0.148***	0.153***	0.200***	0.0565
	(0.0522)	(0.0475)	(0.0449)	(0.0593)
land20082012_D	0.677***	0.324***	0.108	0.191
	(0.123)	(0.121)	(0.121)	(0.147)
building20082012_D	-0.0681	0.393***	0.0132	0.0638
	(0.117)	(0.112)	(0.110)	(0.137)
machine20082012_D	0.341**	0.274**	0.430***	0.292
	(0.142)	(0.137)	(0.124)	(0.178)
training20082012_D	0.130	0.289**	0.487***	1.432***
	(0.117)	(0.114)	(0.111)	(0.141)
TRI	-0.0462**			
	(0.0224)			
Constant	-0.939*	-0.166	-1.059**	-1.817***
	(0.485)	(0.475)	(0.441)	(0.584)
Observations	780	780	780	780
% correctly classidied (all)	77	72	67	85
% correctly classidied (WTI=1)	30	37	65	25
% correctly classidied (WTI=0)	94	88	68	96

References

Ajzen, I. (1991) *The theory of planned behavior*. Organizational Behavior and Human Decision Processes 50(2):179-211.

Andersson, H., B. Ramaswami, et al. (2005) *Offfarm Income and Risky Investments: What Happens to Farm and Nonfarm Assets?* AAEA annual meeting, , Providence, RI.

Benjamin, C. and E. Phimister (2002) *Does capital market structure affect farm investment? A comparison using French and British farm-level panel data*. American Journal of Agricultural Economics. 84(4):1115-1129.

Bierlen, R., B. L. Ahrendsen, et al. (1998) *Impact of financial characteristics and the Boom-Bust Cycle on the Farm Inventory Cash Flow Relationship Inventories*. Journal of Agricultural and Applied Economics. 30:363-377.

Buysse, J., A. Verspecht, et al. (2011) *Assessing the impact of the EU Common Agricultural Policy pillar II support using micro-economic data*. 122nd EAAE Seminar "Evidence-based agricultural and rural policy making: methodological and empirical challenges for policy evaluation", Ancona.

Calus, M., G. Van Huylenbroeck, et al. (2008) *The Relationship between Farm Succession and Farm Assets on Belgian Farms*. Sociologia Ruralis. 48(1):38-56.

Capozza, D. R. and L. Yuming (2001) *Residential Investment and Interest Rates: An Empirical Test of Land Development as a Real Option*. Real Estate Economics. 29(3):503–519.

Cappellari, L. and S. P. Jenkins (2003) *Multivariate probit regression using simulated maximum likelihood*. The Stata Journal. 3(3):278-294.

Ciaian, P., d. A. Kancs, et al. (2012) *Institutional Factors Affecting Agricultural Land Markets*. Factor market working paper 16.

DLG Trend monitor Europe (2013) *Farmers assess their business situation, investments and agricultural policy*.http://www.dlg.org/fileadmin/downloads/Trendmonitor/DLG-TrendmonitorEurope_FactSheet-Spring-2013.pdf. Accessed 11 June 2014

Elhorst, J. P. (1993) *The estimation of investment equations at the farm level*. European review of agricultural economics. 20:167-182.

Esposti, R. (2011) *Evaluating the CAP Reform as a multiple treatment effect: Evidence from Italian farms*. 122nd EAAE Seminar "Evidence-based agricultural and rural policy making: methodological and empirical challenges for policy evaluation", Ancona.

EU (2013) *Regulation (EU) No 1305/2013 of the European Parliament and of the council of 17 december 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005*.

Fałkowski, J. (2013) *Does it matter how much land your neighbour owns? The functioning of land markets in Poland from a social comparison perspective*. Factor markets working paper. 59.

Ferto, I., Z. Bakucks, et al. (2011) *Investment and Financial Constraints in European Agriculture: Evidence from France, Hungary and Slovenia*. EAAE 2011 Congress, Change and Uncertainty Challenges for Agriculture, Food and Natural Resources, Zurich, Switzerland.

Gardebroek, C. and A. G. J. M. Oude Lansink (2004) *Farm-specific Adjustment Costs in Dutch Pig Farming*. Journal of Agricultural Economics. 55(1):3-24.

Glauben, T., H. Tietje, et al. (2004) *Intergenerational succession in farm households: Evidence from upper Austria*. Land Use Policy. 17(2):113-120.

Guastella, G., D. Moro, et al. (2013) *The impact of the 2013 CAP reform on farm investments*. Land, labour and capital markets in European Agriculture. Diversity under a common policy. J. Swinnen and L. Knops. Brussels, Center for European Policy Studies.

Harris, J. M., S. Blank, C. , et al. (2010) *Off-farm income and investments in farm assets: a double-hurdle approach*. AAEA, CAES, and WAEA Joint Annual Meeting, Denver, Colorado.

Hennessy, T. and M. O' Brien (2008) *Is off-farm income driving on-farm investment?* Journal of Farm Management. 13(4):235-246.

Kataria, K., J. Curtiss, et al. (2012) *Drivers of agricultural physical capital development. Theoretical framework and hypotheses*. Factor Markets working paper.

Kirchweger, S., M. Eder, et al. (2011) *Using a matching analysis to evaluate the structural effects of farm-investment support in Austria*. 85th Annual Conference of the Agricultural Economics Society Warwick University

Lefebvre, M., K. De Cuyper, et al. (2014) *European farmers' intentions to invest in 2014-2020: survey results*. JRC Scientific and policy report.doi:10.2791/82963

Lefebvre, M., M. Raggi, et al. (2013) *An analysis of the intention–realisation discrepancy in farmers' land investment decisions*. Review of Agricultural and Environmental Studies. 95(1).

Myyra, S. (2013) *Agricultural credit in the EU*. Land, labour and capital markets in European Agriculture. Diversity under a common policy. J. Swinnen and L. Knops

Oskam, A. J., N. V. Goncharova, et al. (2009) *The decision to invest and the investment level: An application to Dutch glasshouse horticulture firms*. International Association of Agricultural Economists' 2009 Conference, , Beijing, China, August 16-22, 2009.

Oude Lansink, A. G. J. M., J. A. A. M. Verstegen, et al. (2001) *Investment decision making in Dutch greenhouse horticulture*. NJAS - Wageningen Journal of Life Sciences. 49(4):357-368.

Rosenzweig, M. R. and K. I. Wolpin (1993) *Credit Market Constraints, Consumption Smoothing, and the Accumulation of Durable Production Assets in Low-Income Countries: Investment in Bullocks in India*. Journal of Political Economy. 101(2):223-244.

Sauer, J. and D. Zilberman (2012) *Sequential technology implementation, network externalities, and risk: the case of automatic milking systems*. Agricultural Economics. 43(3):233-252.

Swinnen, J., K. Van Herck, et al. (2013) *Land market regulations in the EU*. Land, labour and capital markets in European Agriculture. Diversity under a common policy. J. Swinnen and L. Knops

Upton, M. and S. Haworth (1987) *The Growth of Farms*. European Review of Agricultural Economics. 14:351-366.

Vesterlund Olsen, J. and M. Lund (2011) *The impact of socio-economic factors and incentives on farmers' investment behaviour*. Food Economics - Acta Agriculturae Scandinavica, Section C 8(3):173-185

Weiss, C. R. (1997) *Do They Come Back Again? The Symmetry and Reversibility of Off-Farm Employment*. European Review of Agricultural Economics. 24:65-84.

Weiss, C. R. (1998) *Size, growth, and survival in the upper Austrian farm sector*. Small Business Economics. 10:305–312.