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

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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.

JEL code: Q12

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

I. Introduction

Firm's investment behaviour represents their capital stock adjustments as a response to market opportunities and competitive pressures. If, when making investment decisions, farmers maximize the present value of equity, they would continue to add to their existing stock of asset as long as the present value of the periodic net cash flows generated by an additional unit exceeds the net purchase price of the asset (Penson, Romain, & Hughes, 1981). However, most farm growth strategies would involve investments in several types of complementary assets. Understanding interconnections between different asset categories and the possibility of simultaneous investments is therefore important.

CAP support to invest has been until now directed towards specific single investment projects, mostly in machinery or building. To be supported, the investment project has to fulfil a list of requirements on the nature of the investment and farm holder, specified in the rural development program applying locally, as well as be in line with local priorities. But in recent CAP reform, the idea of holistic approach of the farm investment strategy is made visible. For example, in French 2015-2020 investment support plan for the modernization and adaptation of farm businesses ("Plan de compétitivité et d'adaptation des exploitations agricoles", common to the French 27 regional rural development programs), it is specified that investments candidates for CAP support should be evaluated according to their relevance for the global strategy of the farm holding. The stakes are twofold: First, a better targeting of investment subsidies towards farms involved in a global modernization or growth strategy. Second, a potential multiplier effect of investment subsidies if farms receiving support for one type of asset also engage in other investments. For example, why land investments are not subsidised by EU Rural development policy, a farmer can decide to purchase land if he can receive a subsidy to buy the machinery necessary to farm this new land. In this context, can we really understand farmers' investment strategies focusing on one specific asset category (land, machinery, building …), as often observed in the literature? How the understanding of the connections between the decisions to invest in different asset categories can allow increasing the efficiency and cost-efficacy of CAP investment subsidies?

The objective of this article is to analyse EU farmers' intentions to invest in land, machinery, building and training during the next Common Agricultural Policy programming period (2014-2020), accounting for the possibility of simultaneous investments and the potential correlations among these investment decisions. To do so, we analyze survey data collected from 780 farms 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. The biannual survey DLG Trend monitor Europe (2013) provides recent and multi-country data on farmers' intentions to invest and covers a large sample of 2350 'business-minded' farmers in Europe in four countries (Germany, Poland, France and United Kingdom). 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. Data

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.

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'. 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

[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.

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. Such a sample of more active farmers ought to be appropriate given our interest in the analysis of 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 Lefebvre, DeCuyper 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. In particular for machinery, we know whether the investments aims at replacing existing equipment or it is the purchase of a new equipment 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 the focus on farm investment, we only collected information on training paid for by the farmer.[2]

III. Estimation strategy

1. Econometric approach

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 and the potential correlation between the different decisions. We are also able to distinguish between the purchase of machinery to renew the existing capital stock and the investments in new type of machinery.

A first remark concerns the structure of our dataset. Here, the investment variable is binary (yes/no) and covers the intention to invest in a seven years period. While this data structure precludes dynamic analysis (which is possible with annual data for example), it better captures that investment is not typically an annual decision, but rather it is undertaken periodically, to replace obsolete equipment, or to expand the capital stock. From a technical point of view, it avoids the need for a special statistical treatment to deal with the large majority of zero in one category, which is usually the case with annual data.

The empirical model chosen is the multivariate probit (MVP). The MVP uses a simultaneous equation system that models the influence of the set of explanatory variables on each of the different types of investments. In contrast to the univariate probit model (UVP), the MVP model takes into account the potential correlation among the unobserved disturbances in the intentions to invest equations as well as the relationship between the intentions to invest in different assets. 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 correlation between investments indicates either complementarity (positive correlation) or substitutability (negative correlation). Failure to capture unobserved factors and inter-relationships among investments decisions will lead to bias and inefficient estimates.

The model is specified as a system of five 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 new machinery, Y_4 the intention to invest to replace machinery and Y_5 the intention to invest in training.

$$Y_{ij}^{*} = \beta_j X_{ij} + \varepsilon_{ij}, \;\; j=1,\dots,5$$

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[2] 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.

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

$\varepsilon_{ij} \sim N_j [0,\Omega]$, j=1,…,5

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 Ω, 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.

For comparison, we also report the parameter estimates and marginal effects from an individual probit explaining the investment decisions. In the individual probit model, we use the robust option to obtain heteroskedasticity-consistent standard errors.

2. *Explanatory variables*

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.

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. We provide here 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 as summarized in Table 1.

Farm structure

Farm specialization: Farm specialization influences the type of assets farmers most need. Livestock farmers are more likely to be willing to invest 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.

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.

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. Location is captured here by the altitude (mountain, hill or plain), but also by the country where the farm is located. The country dummies also capture difference in the economic context relevant to explain investment patterns (growth rate, regulation in the land market, interest rate …).

Initial endowment of some fixed or quasi-fixed inputs

Recent investments: 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.(Elhorst 1993)(Vesterlund Olsen and Lund 2011)

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, especially in land or buildings. Land being highly complementary with capital, larger farms invest more in machinery.

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.

Permanent labour: The impact of labour input on investment is expected to depend on the nature of the investment. Investments in machinery can allow reducing labour force, 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 can 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)

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. As the farmer gets older, the future rents he can discount have to be calculated over a shorter time, thereby rendering increased investment less profitable and so decreasing the farmer's willingness to invest. 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 & Oude Lansink, 2004; Oude Lansink, Verstegen, & Van Den Hengel, 2001; Weiss, 1998).

Succession: Investment decreases as the farmer gets older, unless the farmer has a successor, in which case investment increases slightly. The farmer's age and the presence of a successor are nothing but an indication of the time-horizon. The presence of a successor increases the time-horizon and so alters the pattern of the relationship between age and intentions to invest (Elhorst, 1993). 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.

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).

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 (Andersson et al., 2005; Glauben, Tietje, & Weiss, 2004; Harris, Blank C., Erickson, & Hallahan, 2010; Hennessy & O' Brien, 2008; Rosenzweig & Wolpin, 1993; Upton & Haworth, 1987; Weiss, 1997). 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.

Table 1: Definition and descriptive statistics of dependent and explanatory variables

Definition of the variable	Coding	Mean	Std. Dev.	Min	Max
Intentions to invest (dependent variables) =1 if the farmer state an intention to invest in this asset category during the period 2014-2020	Land	0.236	0.425	0	1
	Building	0.306	0.461	0	1
	Machine_new	0.279	0.449	0	1
	Machine_ replace	0.206	0.405	0	1
	Training	0.156	0.363	0	1
Country =1 if the farm is located in this country	CZ(Czech Republic)	0.172	0.377	0	1
	DE (Germany)	0.172	0.377	0	1
	ES (Spain)	0.154	0.361	0	1
	IT (Italy)	0.154	0.361	0	1
	FR (France)	0.172	0.377	0	1
Farm size in hectares and square of farm size	UAA	155.285	361.795	0	3940
	UAA_sq	154841.4	986404.1	0	1.55e+07
Share of rented land over total UAA	sharerentedland	0.384	0.356	0	1
Farm specialization =1 for farms with at least 66% of their overall income comes from this type of production (omitted dummy=mixed farming)	arable	0.258	0.438	0	1
	livestock	0.259	0.438	0	1
	perennial	0.235	0.424	0	1
Legal status: =1 if the legal status of the farm is individual farm	individual	0.813	0.390	0	1
Labour: number of permanent workers on the farm	permanentworker	4.046	14.861	0	151
Location 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 (omitted dummy=plain)	mountain	0.117	0.321	0	1
	hill	0.222	0.416	0	1
Education: variable between 1 to 6 representing level of education of the farm head(1=no or primary only, 6=tertiary	education	2.433	0.843	1	4

education)					
Age of the farm head	age	49.409	10.902	23	85
Interaction dummy = age x a dummy equal to 1 if a successor for the farm has already been identified	age_succesion	25.394	27.019	0	85
Diversification of farmers' activities on the farm: =1 if the farm is diversified with non-farming activities on the farm (tourism, processing of farm products, energy production...)	onfarmother_D	0.237	0.426	0	1
Diversification of farmers' activities outside the farm: =1 if the farm head as a remunerated professional activity outside the farm	offfarmhead_D	0.190	0.392	0	1
Investment support: =1 if the farmer was beneficiary of investment subsidies in 2008-2012	CAP_invsup_D	0.262	0.440	0	1
Existing assets: =1 if the farmer has invested in this asset category between 2008 and 2012	land20082012_D	0.219	0.414	0	1
	bulding20082012_D	0.336	0.473	0	1
	machine20082012_D	0.699	0.459	0	1
	training20082012_D	0.309	0.462	0	1

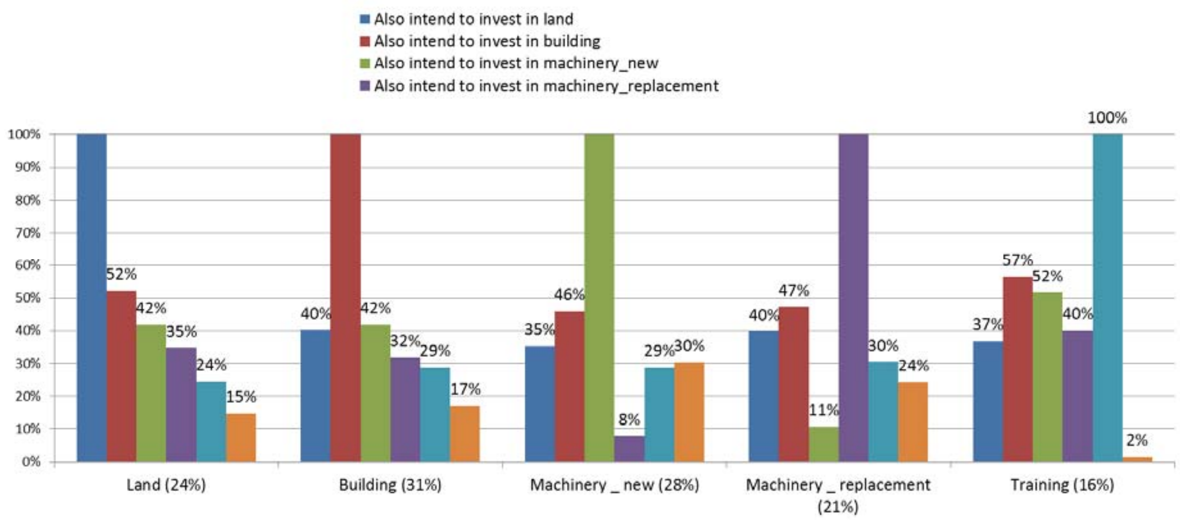
IV. Results

Overall, in the full sample of 780 farmers, it was found that 61% of farmers are willing to invest in the period 2014-2020. 47% of investors planned to invest in machinery, while investments intentions in land, buildings, training are less frequent (24% land, 31% buildings, 16% training). It is not surprising to observe more intentions to invest in machinery, given that such investment are generally smaller in financial terms than investments in land or building, and take place more frequently. But if we distinguish replacement investments and investments in new machinery, we observe that the proportions of farmers intending to invest in new machinery is only 28%, while 21% plan to invest only to renew their equipment.

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.

Interestingly, while 22% of the farmers plan to invest in only one asset class, 37% are willing to invest in several asset classes. For example, among the farmers intending to invest in new machinery, 35% also plan to invest in land, 46% in building and 29% in training over the same period 2014-2020. Only 30% of the farmers with plan to invest in new machinery do not foresee any other investments.

Figure 2: Percentage of farmers intending to invest in other assets among those intending to invest



Reading note: 24% of the farmers are intending to invest in land. Among them, 15% have no other investment foreseen, but 52% also intend to invest in buildings, 42% plan to buy new machinery, 35% plan to renew their equipment, and 24% are intending to invest in training. The total sums add up to more than 100% because farmers can foresee investment in several other assets.

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). The only negative correlation is between investment in new machinery and replacement of existing machinery. 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.

Table 3: Number of farmers intending to invest in the different assets

	Land	Building	Machinery_new	Machinery-replacement	Training	
Land		96 ρ=0.2595	77 ρ=0.1721	64 ρ=0.1941	45 ρ=0.1348	184

Building			100 ρ=0.2058	76 ρ=0.1832	69 ρ=0.2421	239
Machinery_new				17 ρ=-0.1976	63 ρ=0.2273	218
Machnery_ replacement					49 ρ=0.2077	161
Training						122

Reading note: Among the 184 farmers with intentions to invest in land, 96 are also intending to invest in building.

Moreover, in the multivariate probit model, we observe that the pairwise correlation coefficients ρ_{ij} are all (but ρ_{43}) positive and significantly different from zero (Table 3). These coefficients measure the correlation between the intentions to invest in the five 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.

Table 3 performs a likelihood ratio test considering five univariate probit models in contrast to a multivariate solution. The LR test is significant, suggesting the joint significance of the error correlations, implying that using a MVP model is more efficient than using an UVP model (H0 rejected). This result is consistent with significance of error correlation coefficients, supporting the econometric assumption that the intentions to invest in different assets are not independent of each other.

The positive signs of most correlation coefficients 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.

Table 3: Correlation coefficients of intentions to invest equations in the MVP

Equations		ρ	SE
Land-Building	ρ_{21}	0.334***	(0.0730)
Land-Machinery new	ρ_{31}	0.175**	(0.0707)
Land-Machinery replacement	ρ_{41}	0.313***	(0.0788)
Land-Training	ρ_{51}	0.253***	(0.0896)
Building-Machinery new	ρ_{32}	0.279***	(0.0698)
Building-Machinery replacement	ρ_{42}	0.167**	(0.0722)
Building -Training	ρ_{52}	0.433***	(0.0854)
Machinery new-Machinery replacement	ρ_{43}	-0.514***	(0.0852)
Machinery new-Training	ρ_{53}	0.376***	(0.0870)
Machinery replacement-Training	ρ_{54}	0.237***	(0.0881)
Likelihood ratio test of $\rho_{21}=\rho_{31}=\rho_{41}=\rho_{51}=\rho_{32}=\rho_{42}=\rho_{52}=\rho_{43}=\rho_{53}=\rho_{54}=0$: chi2(10)=162.852 Prob>chi2=0.0000			

*** Indicates the correlation is significant at the 0.01 level

2. The determinants of investment intention

The parameter estimates from the multivariate probit are presented in table 4, while results of the individual probits are presented in table 5 for comparison. 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.

The overall rate of correct classification varies between 73.97% and 86.03%, with more than 90% of the no investment intentions correctly classified (specificity) but much less investment intentions correctly classified (sensitivity).

We find that farmers operating large farms (in hectares) are more likely to have stated an intention to invest in land and to be willing to replace machinery. Land being highly complementary with physical capital, larger farms invest more to replace machinery because they existing capital stock is also large. 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 mixed farms. We find that arable farms are more likely to intend to invest in machinery or training, but less likely to invest in building and to renew their equipment. Farms growing mostly permanent crops are also significantly less likely to invest in machinery for replacement, but they are more likely to purchase new type of machinery. Being located in hill and mountain areas compare to plains has no significant impact on intentions to invest.We do not observe any significant impact of the number of full-time workers on the farm on investment.

Farms with a higher share of rented land in the total area cultivated are more likely to intend to invest in land and new machinery. 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. But for those farms with a successor already identified, the negative impact of age is reduced.

We would expect farmers having received more education to be more likely to have stated an intention to invest, because education can favour decision planning. But we do not observe any significant impact.

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 country variables, capturing among others external economic forces, have the expected impact. In those countries were economic growth was close to zero in 2013 (Spain, Italy, France), farmers are less likely to intend to invest. Polish farmers (Poland is the omitted variable) are more likely to invest in all asset categories.

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). It suggests there are both inter- and intra-temporal complementarities between asset types.

V. 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.

The main contribution of the paper is to take into account the potential for simultaneous adoption and correlation among the intentions to invest in different asset classes, using a multivariate probit approach. We have replicated the approach proposed by Velandia et al. (2009) or Lefebvre et al. (2014) to analyse the adoption of risk management instruments. We can conclude that is approach is relevant to analyse investment decisions, given the significance of the correlation coefficients. We find, after controlling for farms and farmers' structural characteristics, that investments in each asset classes are complementary, or, in other words, farmers intending to invest in one asset class are also intending to invest in other asset classes. This result also suggests that many farms are not intending to invest in any asset types. Advisory services should further focus on those farms not investing and work on defining their optimal mix of investments.

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

VARIABLES	(1) Land	(2) Building	(3) Machinery_ new	(4) Machinery_ replacement	(5) Training
CZ	-0.165	-0.114	-0.632***	-0.0618	-0.345
	(0.204)	(0.193)	(0.198)	(0.213)	(0.255)
DE	-0.255	0.0579	-0.339*	0.109	0.271
	(0.205)	(0.196)	(0.197)	(0.210)	(0.242)
ES	-0.251	-1.102***	0.00380	-0.627**	-0.155
	(0.209)	(0.255)	(0.189)	(0.264)	(0.295)
IT	-0.504**	-0.420**	-1.042***	-0.180	-0.0291
	(0.201)	(0.188)	(0.210)	(0.204)	(0.235)
FR	-0.737***	-0.243	-0.535***	0.439**	0.282
	(0.197)	(0.181)	(0.180)	(0.187)	(0.216)
UAA	0.00105**	0.000676	-4.96e-05	0.000789*	-0.000240
	(0.000423)	(0.000443)	(0.000420)	(0.000456)	(0.000476)
UAA_sq	-1.77e-07	-3.89e-08	1.63e-07	-2.60e-07	1.19e-07
	(1.32e-07)	(1.73e-07)	(1.32e-07)	(1.63e-07)	(1.37e-07)
sharerentedland	0.566***	-0.223	0.322*	0.199	0.0789
	(0.180)	(0.174)	(0.169)	(0.180)	(0.209)
arable	0.0832	-0.270*	0.557***	-0.334**	0.521***
	(0.153)	(0.149)	(0.147)	(0.154)	(0.175)
livestock	0.0271	0.105	0.112	0.0302	0.116
	(0.152)	(0.144)	(0.148)	(0.146)	(0.182)
perennial	0.125	0.0284	0.437***	-0.380**	0.0979
	(0.169)	(0.162)	(0.162)	(0.173)	(0.211)
individual	0.207	-0.0781	-0.00318	-0.0222	0.0985
	(0.171)	(0.159)	(0.160)	(0.164)	(0.184)
permanentworker	-0.00832	-0.00152	-0.0124	0.000640	0.00369
	(0.00733)	(0.00703)	(0.00776)	(0.00679)	(0.00714)
mountain	0.0469	0.128	0.290	-0.302	0.0735
	(0.192)	(0.185)	(0.180)	(0.201)	(0.227)
hill	0.0863	0.0166	0.124	0.0866	-0.144
	(0.138)	(0.133)	(0.133)	(0.139)	(0.172)
education	0.108	0.0579	0.0910	0.0135	0.124
	(0.0720)	(0.0738)	(0.0699)	(0.0757)	(0.0847)
age	-0.0148**	-0.0200***	-0.00386	0.000278	0.00284
	(0.00575)	(0.00566)	(0.00544)	(0.00583)	(0.00689)
age_succession	0.00430*	0.00706***	0.00160	0.00299	0.00144
	(0.00233)	(0.00227)	(0.00217)	(0.00229)	(0.00270)
onfarmother_total_D	-0.0985	0.133	0.119	0.189	-0.0718
	(0.144)	(0.132)	(0.138)	(0.140)	(0.161)
offfarmhead_D	0.246*	0.00305	0.00200	-0.0792	-0.351**
	(0.143)	(0.140)	(0.143)	(0.147)	(0.177)
CAP_invsup_D	0.249*	0.0165	0.189	-0.0780	-0.140
	(0.127)	(0.124)	(0.123)	(0.131)	(0.150)
land20082012_D	0.605***	0.231*	0.0974	0.0461	0.231
	(0.126)	(0.123)	(0.125)	(0.130)	(0.146)
building20082012_D	-0.126	0.359***	0.0924	-0.149	0.112
	(0.122)	(0.113)	(0.116)	(0.121)	(0.138)
machine20082012_D	0.301**	0.238*	0.429***	0.281*	0.272
	(0.150)	(0.141)	(0.140)	(0.152)	(0.178)
training20082012_D	0.0872	0.264**	0.459***	0.338***	1.421***
	(0.121)	(0.115)	(0.116)	(0.120)	(0.141)
Constant	-1.156***	-0.0773	-1.328***	-1.240***	-2.683***
	(0.422)	(0.408)	(0.402)	(0.435)	(0.521)
Observations	780	780	780	780	780
% correctly classidied					
(all)	78.72%	73.97%	73.21%	79.74%	86.03%
(investment)	25.00%	37.24%	24.31%	9.32%	31.97%
(no investment)	95.30%	90.20%	92.17%	98.06%	96.05%

Table 5: Individual probit Willingness to invest in the different types of investments

VARIABLES	(1) Land	(2) Building	(3) Machinery_ new	(4) Machinery_ replacement	(5) Training
CZ	-0.163	-0.0956	-0.593***	0.00248	-0.326
	(0.203)	(0.192)	(0.200)	(0.214)	(0.259)
DE	-0.272	0.0586	-0.337*	0.166	0.233
	(0.205)	(0.196)	(0.198)	(0.212)	(0.246)
ES	-0.279	-1.180***	0.00907	-0.658**	-0.170
	(0.210)	(0.259)	(0.189)	(0.273)	(0.303)
IT	-0.504**	-0.425**	-1.073***	-0.190	0.000965
	(0.201)	(0.187)	(0.214)	(0.208)	(0.235)
FR	-0.742***	-0.248	-0.576***	0.490***	0.292
	(0.198)	(0.181)	(0.182)	(0.189)	(0.219)
UAA	0.00102**	0.000609	-7.71e-05	0.000890**	-0.000351
	(0.000425)	(0.000440)	(0.000418)	(0.000449)	(0.000486)
UAA_sq	-1.72e-07	-2.90e-08	1.60e-07	-2.62e-07*	1.47e-07
	(1.31e-07)	(1.64e-07)	(1.30e-07)	(1.54e-07)	(1.40e-07)
sharerentedland	0.576***	-0.193	0.334**	0.186	0.0173
	(0.181)	(0.173)	(0.170)	(0.181)	(0.212)
arable	0.0586	-0.315**	0.558***	-0.343**	0.505***
	(0.154)	(0.150)	(0.149)	(0.156)	(0.179)
livestock	0.0518	0.0987	0.130	0.0327	0.0864
	(0.152)	(0.144)	(0.150)	(0.146)	(0.185)
perennial	0.131	0.0133	0.447***	-0.387**	0.102
	(0.171)	(0.163)	(0.162)	(0.175)	(0.215)
individual	0.193	-0.0945	-0.00414	-0.00572	0.147
	(0.173)	(0.160)	(0.161)	(0.166)	(0.190)
permanentworker	-0.00830	-0.00152	-0.0126	-0.00107	0.00435
	(0.00716)	(0.00685)	(0.00780)	(0.00669)	(0.00726)
mountain	0.0738	0.155	0.278	-0.271	0.118
	(0.190)	(0.184)	(0.181)	(0.196)	(0.233)
hill	0.0758	-0.00853	0.113	0.0803	-0.152
	(0.139)	(0.134)	(0.133)	(0.139)	(0.176)
education	0.0936	0.0384	0.102	0.00586	0.134
	(0.0725)	(0.0746)	(0.0699)	(0.0777)	(0.0867)
age	-0.0147**	-0.0206***	-0.00376	-0.00110	0.00131
	(0.00577)	(0.00566)	(0.00547)	(0.00589)	(0.00705)
age_succession	0.00445*	0.00736***	0.00154	0.00248	0.00210
	(0.00234)	(0.00229)	(0.00217)	(0.00232)	(0.00275)
onfarmother_total_D	-0.107	0.145	0.0998	0.217	-0.0824
	(0.146)	(0.133)	(0.140)	(0.140)	(0.166)
offfarmhead_D	0.245*	0.0129	0.0425	-0.107	-0.393**
	(0.144)	(0.141)	(0.143)	(0.147)	(0.185)
CAP_invsup_D	0.232*	0.0219	0.193	-0.115	-0.136
	(0.128)	(0.125)	(0.123)	(0.134)	(0.153)
land20082012_D	0.604***	0.222*	0.0914	0.0466	0.217
	(0.126)	(0.123)	(0.126)	(0.131)	(0.151)
building20082012_D	-0.147	0.352***	0.100	-0.125	0.0846
	(0.123)	(0.113)	(0.117)	(0.122)	(0.141)
machine20082012_D	0.312**	0.238*	0.427***	0.304**	0.278
	(0.150)	(0.140)	(0.141)	(0.153)	(0.182)
training20082012_D	0.0936	0.264**	0.443***	0.352***	1.445***
	(0.122)	(0.115)	(0.117)	(0.121)	(0.144)
Constant	-1.108***	0.0254	-1.367***	-1.224***	-2.632***
	(0.424)	(0.413)	(0.406)	(0.442)	(0.537)
Observations	780	780	780	780	780
% correctly classidied					
(all)	78.85	74.10	73.85	80.26	86.54
(investment)	25.54	38.91	25.23	13.04	32.79
(no investment)	95.30	89.65	92.70	97.74	96.50

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