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The Measurement Of On-Farm Diversification

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The Measurement of On-Farm Diversification

By

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Abstract

European agriculture is undergoing major processes of change. Globalisation, competition, enlargement of farms, modified support levels and EU expansion are just some of the many factors that have affected and will continue to affect the structure. Over recent decades a process of specialisation has been taking place within agriculture. More and more farmers are specialising and increasing their scales of operation. Simultaneously, there have been large reductions in the number of farmers as well as in the rural population as a whole. Diversification offers an alternative business strategy to specialisation. This paper develops a method for measuring the importance that on-farm diversification has for farm households in a variety of European rural areas. The model analyses different characteristics that affect diversification as well as elements that determine the profitability of on-farm diversification.....to be continued....

1. Introduction

Future rural development will be highly dependent on the ability among the rural population to establish and run new enterprises. However, not all people have the ability to become entrepreneurs. Future firm development is more likely to derive from existing firms and from families that already run companies. The most common rural business entity is the agricultural firm, i.e. the farm. The number of European farmers has decreased during the last decades. Increased competition, rationalisation, large-scale specialised farming, changes in the environmental rules and the decreased number of successors from the generation shifts have resulted in a large reduction in the number of farmers. The remaining farms are increasing in size and scale. There is an urgent need to find new business ideas for those farms that cannot compete in the specialisation and enlargement process. One alternative option for such farmers could be to diversify their farm-based activities.

Local farming is also affected by a number of factors influencing European agricultural development in general. Examples of these factors include globalisation, increased consumer demand, EU enlargement, and increased environmental concern. Through the Agenda 2000 reforms the EU has changed the direction of its rural development ambitions within the Common Agricultural Policy. The new policy aims to create preconditions for the sustainable development of rural areas, for example, by maintaining and creating employment. The EU has motivated this by adopting the following principles:

- The multifunctionality of agriculture, i.e. its varied role over and above the production of foodstuffs. This implies the recognition and encouragement of the range of services provided by farmers.
- A multisectoral and integrated approach to the rural economy in order to diversify activities, create new sources of income and employment and protect the rural heritage.
- Flexible aids for rural development, based on subsidiarity and promoting decentralisation, consultation at regional, local and partnership level.

- Transparency in drawing up and managing programmes, based on simplified and more accessible legislation.”¹

For the development of rural areas on-farm diversification is interesting for several reasons. For example, from an EU perspective it becomes pertinent because of the widespread interest in rural development, the EU enlargement process, the future reduction of agricultural support, and concern for the viability and survival of European farm businesses. From a national perspective it is interesting because of the rural development, the loss of the role of the agrarian sector as a motor of rural development, problems with depopulated rural areas, and employment problems for people leaving farming. From a rural development perspective, it is interesting because of the employment opportunities that on farm diversification could generate in rural areas, especially as farms are the most common type of firms in the rural areas. From the farming and agricultural perspective, diversification is interesting as a possible opportunity for farmers that cannot, or will not, enlarge and/or specialise. Diversification could be a very important option for the survival of farms in all European Countries.

From this respect it is interesting to study on-farm diversification in Europe. We are therefore involved in the collaborative research project “Innovation, Diversification and European Agricultural Situations (IDEAS)”² The IDEAS-project has three main research objectives: (1) to identify dynamic examples of innovative significant on-farm diversification in four EU member states (England, France, Spain and Sweden) with emphasis on employment opportunity creation and the qualitative nature of that employment; (2) to select a variety of localities within four major agricultural regions of Northern and Southern Europe in order to analyse how innovative, significant forms of on-farm diversification are incorporated within the suite of existing on-farm activities; and (3) to evaluate how innovative forms of diversification have been sustained in these

¹ http://europa.eu.int/comm/dg06/rur/index_en.htm

² IDEAS is funded by the Fourth Framework Programme of the European Commission (FAIR6-CT98-4228). The following scientists are involved in the project: Julian Clark and Alun Jones ([University College London](#)), Germana Baudin, Gilles Bazin, Jacques Blanchet, Alain Revel, Bernard Roux and Hervé Vanoverschelde (INRA [Institut national agronomique Paris-Grignon](#)), Gemma Francès Jordi Rosell and Lourdes Viladomiu ([Universitat Autònoma de Barcelona](#)), Ian Layton, Erik Sondell and Ulf Wiberg ([Umeå University](#)).

localities and, in particular, how local/regional institutions and key political actors have interfaced with farmers in their support of innovative on-farm diversification.

In the project, there will be interviews with 125 farmers in each study region. We are using a questionnaire for the interviews, which includes both open and closed questions. The questionnaire contains about 100 questions. The questionnaire was constructed using the project's initial research questions, which are:

What are the factors that have a positive effect on the rise of on-farm diversification innovative experiences? What makes these diversification initiatives 'innovative'? Which are the innovation activities in agricultural diversification? What are the significance of networks, policies, type of farm household (size, age), type of farms, etc.? How have the innovations been supported by public and private agencies? How are innovations in agricultural diversification sustained? How have innovative forms of diversification been sustained? How are innovative significant forms of on-farm diversification incorporated within the suite of existing on-farm activities (adjustment)? How have local/regional institutions and key political actors interfaced with farmers in their support of innovative on-farm diversification? What are the main consequences of innovative on-farm diversification in terms of agricultural activity and rural development? Which are the main policy recommendations?

This paper is about the measurement of on-farm diversification. The purpose is to develop a method for measuring on-farm diversification using the data we have collected through interviews with farmers in the four study regions. The paper consists on five sections. After this introduction -section 1-, a conceptual approach about the definition and the determinants of on-farm diversification are developed. Following in section 3, we proceed with the measurement of on-farm diversification. To this end, firstly we determine the variables considered in the model and introduce some concepts for the measurement; secondly, we develop indicators from the many variables investigated in order to measure on-farm diversification; and, thirdly, we develop an econometric model. The final section concludes the paper with a summary of what we hope to achieve with this method.

2. Conceptual approach to on-farm diversification

2.1. The definition of on-farm diversification.

In the IDEAS project we define on-farm diversification as “environmentally-friendly complementary on farm activities that provide significant employment opportunities not only on the farmstead, but also upstream and downstream of it”.³ This is a very broad definition and on-farm diversification can therefore contain a wide variety of activities such as new agricultural products (e.g. biomass, production of local livestock breeds/plants), new production processes (e.g. low-input farming practices), new market behaviours (e.g. direct marketing, increased demand for specialist crops, or niche products), use of new raw materials (e.g. use of new prophylactic crop treatments), a new form of farm business organisation (e.g. partnerships, collectives, and group farming), or new non- or semi-agricultural products or services (e.g. manufacture, agro-tourism, gross or retail sales).

It is necessary to establish some operative delimitations to the concept of diversification, in order to determine what kinds of activities are included or excluded. The first delimitation is between on-farm and off-farm diversification. On-farm diversification means that the new, or changed, activities are based on the farm, for example a shop located on the farm premises. Off-farm diversification means activities that are run and located outside the farm, for example a shop in a nearby town.

Another delimitation is between innovative and non-innovative on-farm diversification, which is characterised by “...its conceptualisation as a knowledge and resource-based process with the redeployment of factors and knowledge of production in farm businesses as a means of achieving new goals, enabling farm businesses to position themselves on new socio-economic trajectories”.⁴ Examples of innovative on-farm diversification could be farmers that develop (even invent) a completely new activity (a product or a service) or farmers that are the first to start up a new activity in a region.

³ From the technical annex of the IDEAS research proposal.

⁴ Ibid.

Non-innovative on-farm diversification consists of activities which could be for example traditional or copied from other local farmers.

The third delimitation is between significant and non-significant on-farm diversification, where the former is characterised by “New activities which are generated by farmers/farm household members and which have a major bearing upon the organisational/production profile of the farm as a household/business”.⁵ The significance could, for example, be measured in terms of employment creation and/or income contribution and/or work creation. Less significant diversification would then be activities that do not lead to higher levels of employment, work or income.

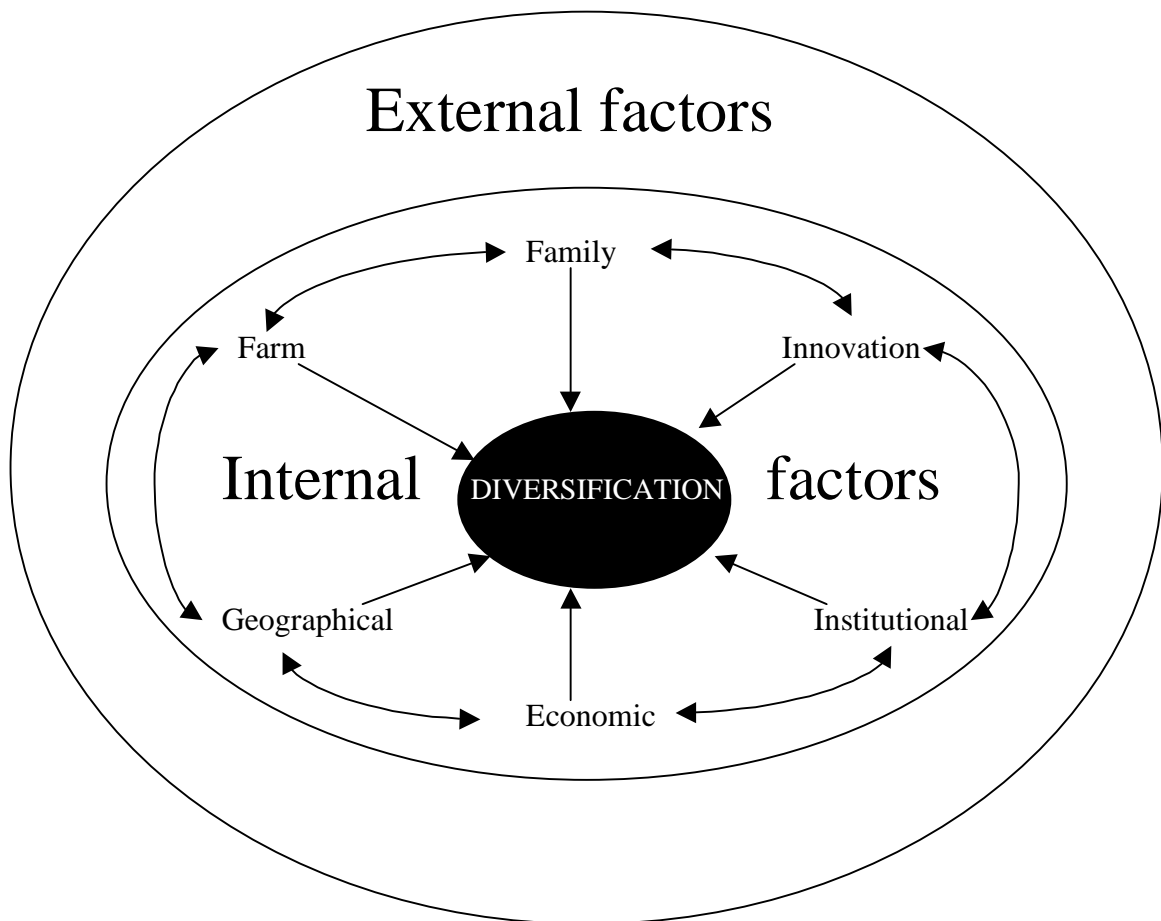
Regarding the problem formulation in measuring on-farm diversification (innovative or non-innovative, significant or non-significant), one has to decide what to measure and how. In this sense it is important to build indicators from the variables and then make some classification in order to measure diversification. This will be done in the following sections. The project’s objective and our research questions provide the starting point for the creation of indicators. We believe that these conceptual delimitations for on-farm diversification could prove very useful for gaining a better understanding of the impact that diversification has on the agrarian household, as well as in rural areas.

2.2. The factors that determine the development of on-farm diversification

Here we introduce some factors that we believe affect the origin and growth of on-farm diversification (see figure 1). ~~Both internal factors within the farm household~~ External factors (institutions, legislation, politics and market) as well as internal factors within the farm household ~~can~~ affect the preconditions for diversification. Far from being mutually exclusive, the figure’s six internal factors tend to overlap and must be perceived as interacting closely with one another. The family factor consists of variables related to the farm household(s) living on the farm, such as age, size, educational level, off-farm work, etc. The farm factor comprises, for example, the land area, quality and land use (arable, meadow, pasture, forest), the type of enterprise, the type of production, etc. The

⁵ Six month report.

geographical factor includes the location of the farm and the localised embeddedness of the farm household. The economic factor consists of the farmer's invested capital, the turnover, the loans, entrepreneurship, etc. The innovation factor is the ability among the farm household to create or adopt new ideas/activities. Lastly, tThe institutional factor includes, for example, the farmer's use of~~use of~~ advisory institutions and financial aid.



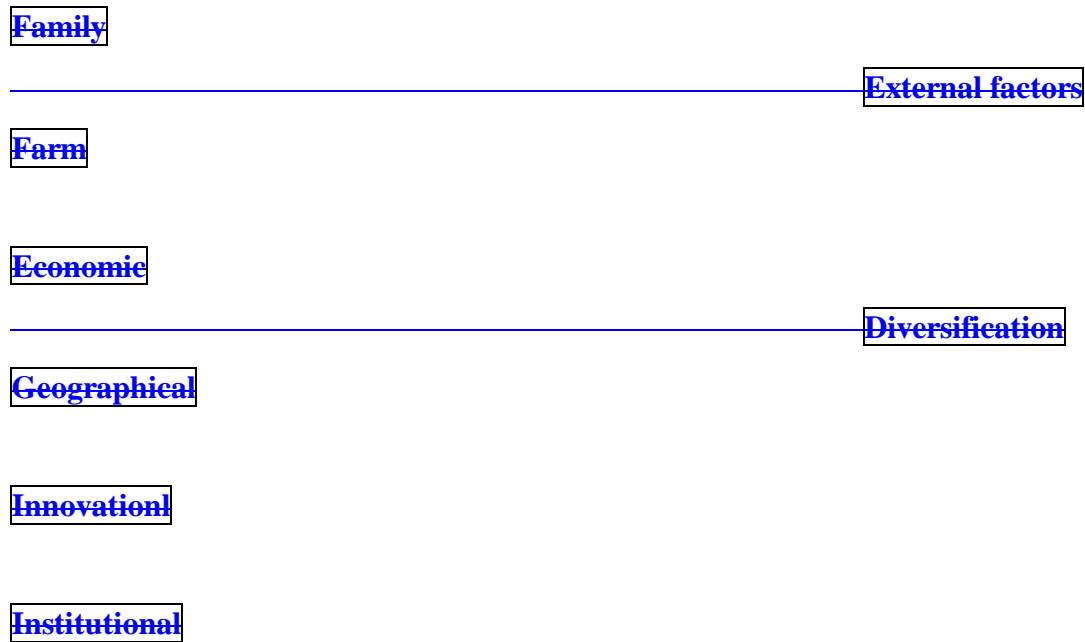


Figure 1 Conceptual model of factors that have impact on diversification. ~~(We are working on a better illustration here!)~~

The farm household works in a spatial environment where the farm interacts with the local, regional, national and international arenas, the market, the local/regional institutions and key political actors. Hence, network aspects such as location and interface are also important factors for the output of diversification. The farm household arena is shown in figure 2. Politics interface with all levels of arena via such policy measures as agricultural support, tax regulations, special price supports, transport subsidies and various other forms of financial support. The analysis of how the farm business adjusts in order to sustain diversification activities can therefore be made in a spatial context. For example, both the incorporation of diversified activity into the existing on-farm activities and the sustainment of innovative forms of diversification depend on several interactions within the structure of the farm, the local arena preconditions, the market possibilities, and the interface with local/regional institutions and key political actors.

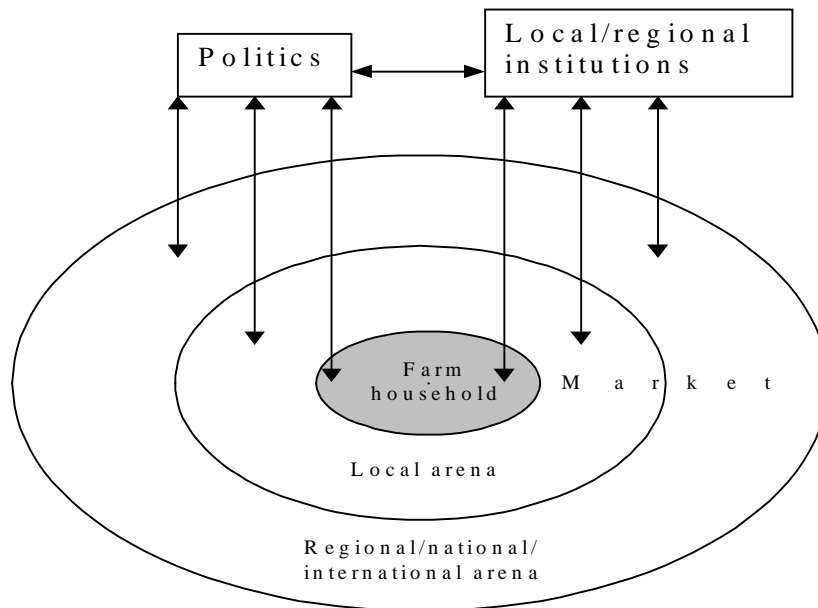


Figure 2 The arena for farm diversification.

3. The measurement of on-farm diversification

~~In order to~~ In order to measure on-farm diversification it is necessary to decide exactly what should ~~all~~ be measured and how. In general terms we want to measure the importance that on-farm diversification has on the households of the different study areas.

Under the vision of integrated rural development, the household is not only interpreted as a productive unit. The household is regarded ~~seen~~ as an element that is related to and integrated with the socio-economic, cultural and environmental contexts. From this point of view, ~~as we mention above (section 2.2.), the~~ on-farm diversification process depends on the socio-economic character of the farm, the institutional support, the geographical context and the economic situation in ~~of~~ the area ~~region~~ — where the farm is located.

To ~~know~~find the relevance that on-farm diversification process has ~~for~~on the household, ~~firstly~~-we first have to determine the variables that ~~needare to be considered~~ing within each internal and external ~~all~~ factors that ~~determine~~influence the development of on-farm diversification. For the purpose of measurement, these variables need to be quantified and this will be done through the creation of indicators later in the project.

3.1 Factors variables

3.1 Factor variables

The Socio-economic Context of the Farm

As mentioned before, from the farming and agricultural perspective on-farm diversification is interesting as a possible option for the survival of farms. Under this point of view, it is necessary to consider those elements directly linked with the farm such as the family, physical and economic farm factors.

Family variables show the family structure of the farm. The number of members, their ages, education and successor can give some idea of the level of motivation and dynamism within the households. Off-farm activities can be regarded as positive elements in the process of on-farm diversification, because they can contribute towards maintaining the viability of the farms and provide a financial source for on-farm diversification. On the other hand, the transfer of family workforce from on-farm to off-farm activities can have a negative bearing on the process of on-farm diversification and, finally, on the survival of the farm and the rural landscape.

We consider the presence of newcomers to rural areas because it can have opposite effects on the process of on-farm diversification. On one hand, the arrival of newcomers contribute positively to the dynamism of rural areas in terms of improving population and economic trends (increasing population, rejuvenation of ageing population tendency,

generation of economic activities, increasing demand of new services, etc) and also transferring new skills and knowledge to the agrarian activity (new techniques of agricultural cropping or husbandry, new types of contracting new ways of marketing commercialisation, etc). On the other hand, the presence of newcomers can generate some social conflict with the native population that can hinder the process of on-farm diversification.

Together with the family variables, physical and economical farm variables are also essential to determine and measure the impact of on-farm diversification. We have considered several physical variables such as the size, the economic turnover, tenure, farm enterprise type, and irrigation (to differentiate its impacts in terms of profitability in comparison to non-irrigated land). Finally, we consider the seasonal nature of agrarian activity as a variable that can contribute to the process of on-farm diversification. Among the economic farm variables we consider those related to employment, income and investment.

Institutional and Economic contexts

In order to analyse the impact of the institutional and political context in on-farm diversification, it is necessary to consider several variables. The existence of means of support at EU, national or regional level and the use of these by the farmers gives rise to the idea of attempting to measure the dynamism and effectiveness of farmers in utilising such aids. In certain cases co-operatives or their unions contribute to new strategies as well as extension groups.

On the other hand, the existence of networks has an important effect on reducing the problems of isolation that are very common in rural areas. Networking provides the framework for the circulation of information (formal and informal), for the exchange of experiences and technical assistance, and for creating and boosting synergies among rural areas. Associations can play also an important role in fostering the on-farm diversification process. All these questions figure as variables in order to discover whether or not networking and associations are significant and positive to on-farm diversification.

Macroeconomic Context

Economic cycles have a relevant influence on the development of economic activity and, by extension, on the on-farm diversification process. It therefore becomes necessary to consider certain macroeconomic variables such as unemployment rate, participation rate and income per capita, in order to analyse the extent of the effects of the macroeconomic environment on the on-farm diversification process.

Geographical context to the Farm

Most rural areas are facing some form of geographical constraint. Peripheral situations in conjunction with the process of modernization have resulted in a vicious circle in the less favoured areas. Geographical constraints have generated problems of isolation that tend to lead to processes of depopulation and the ageing of population. In turn, these processes have an impact on the lack of services – and so on.

On the other hand, geographical or physical elements can also contribute positively to the development of some economic activity and increasing the income earned outside agriculture, through the developing a range of "green" activities that also, contribute to enhance the natural and cultural heritage.

3.2. Building an appropriate typology of on-farm diversification

~~We have received your draft about the typology. We want to see carefully!!!!!!
The typology must follow the scheme made by Alain Revel in Paris (see the photocopy).
Revel's typology may be the best one, but we could consider other options, se below...~~

Diversification is defined as the sum of new productions, techniques or activities within the same agricultural enterprise. Within this widely definition it is necessary to establish a

typology of the ways of practising on-farm activities in order to measure and specify the impact on the household's profitability.

On the other hand, the same on-farm diversification activities may be interpreted differently in the different countries studied. Households in the European Union countries are strongly marked by their history, their economic and social environment and their institutional framework. As some studies have pointed out (Bowler, I.; 1999), the most suitable choice of on-farm diversification activities can vary among each country.

We proceed to establish the following typology of on-farm activities:

- A) *Agricultural production diversification*: that includes on one hand, new types of agricultural products such as non-traditional farm crops and livestock, agro-forestry, fish farming and apiculture.
- B) *Increasing the agricultural value-added and agricultural services and agrarian valorisation of the farm assets*. In this section we include that activities that contribute to increase the valorisation of the agrarian products such as on-processing crops and livestock; direct marketing of farm products, contracting agrarian machines, agricultural services or leasing of land or buildings for agricultural purposes.
- C) *Non- agricultural services*: that includes those activities non related directly with the primary sector such as tourism and recreational activities; landscape protection and environmental activities; handicrafts manufacture and professional services.
- D) *New methods of production, new technologies*: including innovative type of production such as organic farming and integrated crop management; agri-environment practices (no tillage, etc); new seeds (GMO - genetic modification) and those activities related to the application of new technologies (telework and other activities based on new technologies or communications) .

4. The model: variables to consider and statistical treatment.

Starting from the institutional and non-institutional literature which point out that diversification can contribute to the survival of the farm and to reduce the traditional problems which face rural areas, we propose a theoretical model of measurement on-farm diversification. The objective is to valorate the relevance that on-farm diversification has on the survival of the farm in other words, the impact that on-farm diversification has on the profitability of the households.

To this end, we propose the following theoretical model to evaluate the effects of diversification decision.

The null hypothesis is that on-farm diversification contributes significantly to increasing the household's profits. The model contrasts the significance that diversification has on the increase of profitability.

First of all, we have to determine which elements contribute to the decision to diversify, and secondly, once the farmer diversifies, what is the intensity of diversification.

Diversification cannot be estimated directly. We have to use some indicators as a proxy of these meaning. In that sense we use two indicators:

- A. Diversification as a % of time devoted to on-farm diversification in relation to the total of working time in the farm. Dependent variable, L .
 - B. Diversification as a % of on-farm diversified activities income. Dependent variable, Y .
- We will estimate both indicators and then compare the results between them.

4.1 Theoretical Model

Under the assumption that a household has n possible activities of diversification, the decision to diversify will be made when the net global profitability of diversification is

positive and, also, when the total profitability of the household after diversification is bigger than when the farmer does not diversify. Hence the prospective profits from diversifying can be estimated by comparing the value added generated by those who diversify and those who do not diversify.

The diversification profitability rate is the variable we use to compare the income or value added that the household obtain in the two schemes, that are, diversification and non diversification. The profitability of diversification depends directly on the characteristics of the household (defined in section 3.1). It is possible that two households with the same diversification activities, but with different characteristics (C), have different profitability rates.

In conclusion, the profitability of diversification for each activity that can be carried out in the household depends directly on the Matrix C. Thus, what we determine is which are the most significant characteristics that contribute positively to the diversification decision. These characteristics are the elements that determine the profitability of on-farm diversification.

Now we proceed to model the diversification decision, starting from the microeconomic modelling of net expected profit of the household. The methodology of the theoretical model presents the following stages:

To simplify the model we assume that there are only two on-farm diversification activities (a,b)⁶

Consider $Y_a(d)$ and $Y_b(d)$ are the income or value added generated on the household by the on-farm diversification activities (a,b respectively), where d reflects the % of time devoted to on-farm diversification in relation to the total working time in the farm or the % of on-farm diversified activities income:

$$Y_a(D) = (1 + \sigma_a) D + Y_0 - D = \sigma_a D + Y_0$$

$$Y_b(D) = (1 + \sigma_b) D + Y_0 - D = \sigma_b D + Y_0$$

In which σ_a and σ_b is the net return obtained with probabilities π and $1-\pi$ respectively of on-farm diversification activities, a and b.

According to this modelling, the net expected profit of the household depends on D .

$$\tilde{B}(D) = \sum_{i=1}^n \pi_i b(D) \quad (1)$$

where $n = 2$

Including the values of $Y_a(D)$ and $Y_b(D)$ in the expression (1), it can be expressed in the form:

$$\tilde{B}(D) = \pi b(Y_a(D)) + (1 - \pi) b(Y_b(D))$$

The household faces up to a problem of expected profit maximization.

$$\text{Max}_D \tilde{B}(D)$$

subject to the following constraints:

Assume one on-farm diversification activity (a) has a positive return and the other (b) has a negative return. The problem is to determine the decision of on-farm diversification and its optimum amount.

- D restrictions

We assume that diversification can not take a negative value:

$$D \geq 0$$

- Returns restrictions:

⁶ The assumption of two activities does not affect the results in the case of increasing to n on-farm diversification activities.

We assume that $\sigma_a > 0$ and $\sigma_b < 0$, expecting net returns of on-farm diversification is:

$$\tilde{\sigma} = \pi \sigma_a + (1 - \pi) \sigma_b > 0$$

Additionally, we suppose that this return is positive because on the contrary the farmer would not diversify.

The decision variable is D and it is assumed that:

$$Y_a(D) > Y_b(D) \geq 0$$

We want to obtain a value of D , such that

$$0 \leq D \leq \tilde{D} = \frac{Y_0}{-\sigma_b} \quad \begin{array}{l} > Y_0 \text{ si } (-\sigma_b) < 1 \\ < Y_0 \text{ si } (-\sigma_b) > 1 \end{array}$$

The household decides to diversify when the global expected net return is positive,

The maximisation problem is:

$$\text{Max}_D \tilde{B}(D) = \text{Max}_D \pi b(Y_a(D)) + (1 - \pi) b(Y_b(D))$$

So that,

$$\begin{aligned} Y_a(D) &= (1 + \sigma_a) D + Y_0 - D = \sigma_a D + Y_0 \\ Y_b(D) &= (1 + \sigma_b) D + Y_0 - D = \sigma_b D + Y_0 \end{aligned}$$

Subject to the following restriction:

$$0 \leq D \leq \tilde{D} = \frac{Y_0}{-\sigma_b}$$

∩

As $B(D)$ is a continuous function defined on a compact set, so that, it has a maximum and a minimum point. So, there is a solution $D^* > 0$.

The optimum solution to the maximization problem has to verify that:

$$\frac{\partial \tilde{B}}{\partial D} = \pi \sigma_a b'(\sigma_a D + Y_0) + (1 - \pi) \sigma_b b'(\sigma_b D + Y_0) = \tilde{B}'(D)$$

When there is no diversification, the previous expression is given by:

$$\tilde{B}(0) = \pi\sigma_a b'(Y_0) + (1 - \pi)\sigma_b b'(Y_0) = (\pi\sigma_a + (1 - \pi)\sigma_b) b'(Y_0) > 0$$

As b is an increasing function, the previous expression is bigger than zero. So that, $D = 0$ is not the optimum solution, it gives the return's threshold. The household's members decide not to diversify below this return's threshold, because they expect a positive return when they diversify.

4.2 Estimation Methodology

We initially assume that diversification can be a potential element of increasing significantly the household's net expected profit. In the sample we have diversifiers and non-diversifiers. As we just know the effects that diversification has over the net expected profit on these households that have yet diversify, we faced up to a problem of sample selection. If we do not correct that problem we will obtain a biased estimators of the effect that diversification has over the household's net expected profit.

To correct the problem of selection sample we estimate, on one side, the net expected profit to the diversified households and on the other side, to those that not diversify.

If diversification is given by $D = \alpha_0 + \alpha_1 (C) + u_1$,

$$D = \hat{C} + \varepsilon \quad \text{if } \hat{C} + \varepsilon > 0$$

$$D = 0 \quad \text{if } \hat{C} + \varepsilon \leq 0$$

Diversification likelihood is given by:

$$P = \Pr(\hat{C} + \varepsilon > 0) = \Pr(\varepsilon > -\hat{C}) = 1 - F(-\hat{C})$$

where F is the accumulated distribution of ε .

Diversification expecting value when it is positive, is given by the following expression:

$$E[D / D > 0] = E(\alpha_0 + \alpha_1 C + \varepsilon > -\hat{C}) = E(\hat{C} + \varepsilon > -\hat{C}) = \hat{C} + \frac{1}{1 - F(-\hat{C})} \int_{-\hat{C}}^{\infty} \varepsilon f(\varepsilon) d\varepsilon = \hat{C} + \frac{f(-\hat{C})}{1 - F(-\hat{C})}$$

If the ε are normally distributed (normal estàndar), the previous expression takes the following form:

$$E(D) = E(D / D > 0) \Pr(D > 0) = \left\{ \hat{C} + \frac{f(-\hat{C})}{1 - F(\hat{C})} \int_{-\hat{C}}^{\infty} \varepsilon f(\varepsilon) d\varepsilon \right\} F(\hat{C}) = \left\{ \hat{C} + \frac{f(-\hat{C})}{1 - F(-\hat{C})} \right\} F(\hat{C})$$

To conclude, the model that we have to estimate is:

$$B_{di} = \beta_d C_i + u_{di} \quad \text{Si } \gamma \hat{C}_i + \varepsilon_i > 0 \quad (D_i = 1)$$

$$B_{ndi} = \beta_{ndi} C_i + u_{ndi} \quad \text{Si } \gamma \hat{C}_i + \varepsilon_i \leq 0 \quad (D_i = 0)$$

We proceed to define the log likelihood function corresponding to the differents sample groups:

$$L_j = \pi_{i \in T_{1j}} \left[\int_{-\gamma \hat{C}_i}^{+\infty} g(B_{di}, \varepsilon_i) d\varepsilon_i \right]^{D_i} \pi_{i \in T_{2j}} \left[\int_{-\infty}^{-\gamma \hat{C}_i} f(B_{ndi}, \varepsilon_i) d\varepsilon_i \right]^{1-D_i}$$

Where:

- $\forall i \in T_{1j}$, i is a diversified activity, and $\forall i \in T_{2j}$, i is a non-diversified activity, such that $T_{1j} + T_{2j} = T_j$,
- $g(\dots)$ and $f(\dots)$ are the density functions of two bivariant normal distribution.

If we define y_i and z_i respectively, as the maximum and minimum limits of profitability that can be reach diversifying and non-diversifying this expreion takes the following form:

$$L_j = \pi_{i \in T_{1j}} \left[\int_{-\gamma \hat{C}_i}^{+\infty} \int_{y_i}^{z_i} G[(B_{di} - \beta_d C_{di} / \sigma_d), \varepsilon_i] d\left(\frac{B_{di} - \beta_d C_{di}}{\sigma_d}\right) d\varepsilon_i \right]^{D_i} \pi_{i \in T_{2j}} \left[\int_{-\infty}^{-\gamma \hat{C}_i} \int_{y_i}^{z_i} J[(B_{ndi} - \beta_{nd} C_{ndi} / \sigma_{nd}), \varepsilon_i] d\left(\frac{B_{ndi} - \beta_{nd} C_{ndi}}{\sigma_{nd}}\right) d\varepsilon_i \right]^{1-D_i}$$

Where $G(\dots)$ and $J(\dots)$ are the density functions of bivariate normal distribution with unit variance, and the values of y_i and z_i are given by:

$$y_i = \frac{Y_i - \beta_k C_{ki}}{\sigma_n}$$

$$z_i = \frac{Z_i - \beta_k C_{ki}}{\sigma_k}$$

Where k = diversify and non-diversify activities.

4.3 Modeling to the diversified households

$$E(B_{di} / D_i = 1) = E(\beta_d C_{di} + u_{di} / D_i = 1) = E(\beta_d C_{di} + u_{di} / \delta \hat{C}_i + \varepsilon_i > 0) = \beta_d C_{di} + E(u_{di} / \varepsilon_i > -\delta \hat{C}_i)$$

Where,

$$E(u_{di} / \varepsilon_i > -\delta \hat{C}_i) \neq 0$$

Given that, applying least square to the equation $D_{di} = \beta_i C_{di} + u_{di}$, we obtain inconsistent estimators:

$$E(u_{di} / \varepsilon_i > -\delta \hat{C}_i) = \sigma_{d\varepsilon} E(\varepsilon_i / \varepsilon_i > -\delta \hat{C}_i) = \sigma_{d\varepsilon} \frac{\phi(-\delta \hat{C}_i)}{[1 - \Phi(-\delta \hat{C}_i)]}$$

Where ϕ i Φ are respectively, the standard normal probability density and distribution functions. The expression that we obtain to $\varepsilon_i \sim (0, \sigma_\varepsilon^2)$ is:

$$E(u_{di} / \varepsilon_i > -\delta \hat{C}_i) = \sigma_{di} \frac{\phi(-\delta \hat{C}_i / \sigma_\varepsilon)}{[(1 - \Phi(-\delta \hat{C}_i / \sigma_\varepsilon)) \sigma_\varepsilon]}$$

To estimate this equation in a consistent way, we should apply least squares to:

$$B_{di} = \beta_d C_{di} + \lambda_i \sigma_{d\varepsilon} + u_{di}^*$$

Where

$$\lambda_i = \frac{\phi(-\delta\hat{C}_i)}{[1 - \Phi(-\delta\hat{C}_i)]}$$

4.4 Modeling to non-diversified households:

$$E(B_{ndi} / D_i = 0) = \beta_{nd} C_{ndi} + E(u_{ndi} / \varepsilon_i \leq -\delta\hat{C}_i) = \beta_{nd} C_{ndi} - \sigma_{nd\varepsilon} \left[\frac{\phi(-\delta\hat{C}_i)}{\Phi(-\delta\hat{C}_i)} \right]$$

So that, if we want to estimate consistently, we have to apply least squares:

$$B_{ndi} = \beta_{nd} C_{ndi} + \sigma_{nd\varepsilon} \tau_i + u_{ndi}^*$$

Where

$$\tau_i = \frac{-\phi(-\delta\hat{C}_i)}{\Phi(-\delta\hat{C}_i)}$$

This will be the modelling scheme (1) but there are also two other situations: one (scheme 2) situation is when the global net return is negative where the optimum decision is not to diversify; and the other (scheme 3) is when it is positive then the optimum decision is to diversify⁷.

⁷ **2 SCHEME:** Situation in which diversification global net return of is negative. In this case, the optimum solution is not to diversify.

Maximisation function depends on the following restrictions:

- D restrictions: we assume that diversification cannot take a negative value:

$$D \geq 0$$

- Returns restrictions: we assume that $\sigma_a < 0$ and $\sigma_b > 0$, expecting net returns of on-farm diversification is:

$$\pi\sigma_a + (1 - \pi)\sigma_b \leq 0$$

The optimum decision is not to diversify because, expecting net returns is negative, so that, $D^* = 0$.

3 SCHEME: situation where the expected net return of on-farm diversified activities is positive:

Maximisation function depends on:

- D restrictions: we assume that diversification can take a negative value:

$$D \geq 0$$

5. Concluding remarks

This paper develops a method for measuring the importance that on farm diversification has for farm households in a variety of European rural areas.

We approximate the concept "survival of the farm" in terms of profitability. So that, the null hypothesis is that diversification increases the household's profits. If the farmer believes that diversification has a significant impact on the profitability, his decision will be obviously, diversify. The theoretical model sets out a maximization problem under possible activities of diversification.

As we pointed above in the text, diversification and its process is determined by internal and external factors. It is possible that the profitability of a diversify activity between two households vary because those internal and external factors. In this context, under the assumption that diversification contributes to the "survival of the farm" in terms of profitability, the approach used here for measuring the importance of on farm diversification, involves a first probit modelling of the significance and relevance of the household's characteristics over the on farm diversification probability. We consider that the existing arrangement between heterogeneous on farm household's characteristics can, in a substantial way, determine the net profitability rate of one and so, it can seriously determine different diversification probabilities for two households accordingly to its exposure degree to different internal and external factors. This is one of the most important information that the model gives, because we will be able to detect those elements that are significant -positively or negative- to diversification and to establish some suggestions of policy.

Once the importance and significance of these internal and external factors are determined, the last step of the measurement is contrast the significance that

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- Returns restrictions: we assume that $\sigma_a > 0$ and $\sigma_b > 0$. In this situation the expected net

diversification has on the increase of profitability. To that end, we will compare the profitability between the sample of diversifiers and non-diversifiers using the Ordinary Least Square method.

This method should enable us to obtain empirical results and to examine the impact that on farm diversification has on rural development under the evolutionary (Sundbo, 1995) and network theoretical (Lowe, P. et al.; 1995; ...) approaches used in the IDEAS project.

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