Determinants of farm diversification and interaction with the CAP. An application to FADN of Marche region (Italy)

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Abstract — **This work analyzes farm diversification activities in an Italian region (Marche). The study examines 387 farms from Farm Accountancy Data Network (FADN) over a six-year period (2000-2005), applying Discrete Choice Models to identify their business. Recognizing the driving forces of such diversification strategy can be useful to better design those agricultural policies explicitly aimed at promoting agricultural multifunctionality as well as social and environmental sustainability. The linkage between diversification choices and CAP payments is thus also investigated.**

Keywords— **Farm diversification, Discrete Choice Models, Multifunctionality**

I. INTRODUCTION

Diversification is a classic topic of firm behaviour analysis in both economics and business studies [1] [2]. Major interest is on the primary motivations of diversification choices, these being often linked to risk reduction or strategic choices within oligopolistic or imperfectly competitive markets. This also explains why diversification strategies are usually analysed with major emphasis on large corporations and their strategies [1].

Nonetheless, analysis of diversification is also a major topic in agricultural economics, though farms are mostly characterized by relatively small size and prevalently operate in competitive markets. Since [3], agricultural economists have paid attention to farm diversification mainly because motivations to diversify seem particularly relevant in agriculture. Firstly, risk reduction is a key issue in farm management as environmental and markets' volatility is typically high in farming. Secondly, and more specifically, farm diversification is strongly induced by technological characters of farming, that is, the presence of technical interdependencies or non-allocable inputs, eventually generating jointness in production [4].

Interest on this latter aspect significantly renewed in recent years mostly due to the emerging concept of multifunctionality [5], [4] [6]. In fact, this concept assumes major relevance in agricultural economics research after the EU started to renew and reform its Common Agricultural Policy (CAP) in this direction. The second pillar of the CAP (i.e., the Rural Development Policy), in particular, has been designed to supposedly reorient European agriculture towards multifunctionality (the so-called new European model of agriculture) [7].

Diversification of farm activities can be, in fact, interpreted as the rationale choice made by farmers to create values from these multiple functions of farming either through markets (e.g., agritourism or organic agriculture) or through participation to policy programmes. Recent empirical literature on farm diversification choices often takes the form of investigation on farmers participation to schemes, measures, programs, contracts, practices founded by specific agricultural or rural policies [8], [9], [10], [11], [12], [13]. Very few studies, however, carried out an overall evaluation of the motivations underlying farm diversification, regardless the specific form it can take in response to contingent policy programmes or market favourable conditions.

This paper analyzes the motivations underlying recent multifunctional farm diversification in one Central Italian region (Marche), just starting with an explicit identification and classification of diversifying activities. Alternative Discrete Choices Models (DCM) are then estimated to identify variables influencing farmer choices. These binary or multiple choice models are applied to a panel of FADN (Farm Accountancy Data Network) farms observed over a six-year period (from 2000 to 2005). Issues concerned with application of panel DCM to farm diversification analysis are mostly unexplored. This paper thus aims at providing an original empirical contribution in this direction.

Once identified the major drivers of diversification choices, these latter are finally correlated with CAP payments. In principle, policy support may either be the cause or the consequence of diversification choices. Thus, the primal aim here is to understand if a relationship between subsides granted through first (I) and second (II) pillars of the CAP and these diversification choices actually occurs. Though apparently only descriptive and not explicative of the role of policies, nonetheless, this empirical evidence is of major interest for an initial detection of the relevance of the CAP in favouring multifunctional diversification.

II. MULTIFUNCTIONAL DIVERSIFICATION AND FARM CHOICES: BASIC MODELLING CONCEPTS

Building a conceptual framework to analyze multifunctional farm diversification requires two steps.

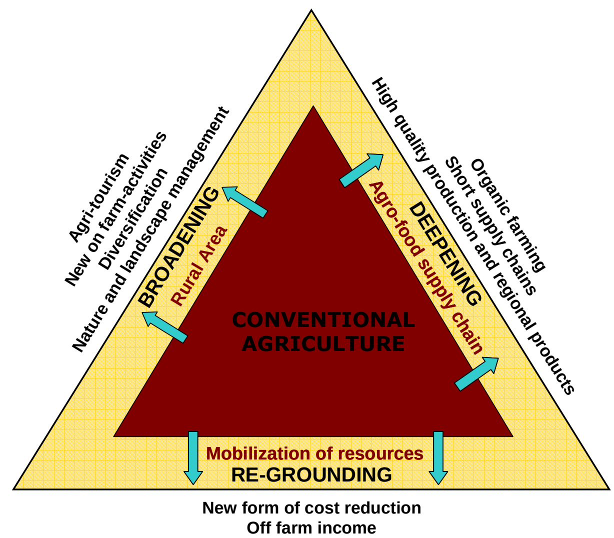
Firstly, we need a consistent definition of what is meant by multifunctional diversification and a classification of the respective farms activities. Secondly, we must specify a theoretical model shaping the rationale underlying farmer diversification choices.

On the first aspect, we mainly rely on the classification scheme outlined by van der Ploeg et al. [14] (Fig. 1), as this framework specifically put the attention on diversification towards multifunctional agriculture (i.e., multifunctional diversification), that is, outside the limits of typical multi-crops or multi-livestock production of “conventional agriculture”. The basic idea behind this framework is that, beside the core-business of traditional agricultural activities, farm development and performance improvement can be achieved through three alternatives strategies: *deepening*, *broadening*, *regrounding*, each of them consisting in an expansion of farm business towards new activities, new markets, new managerial solutions.

Deepening concerns activities integrated to traditional ones but pursuing product innovation and product quality valorisation along the food supply chain.

Broadening refers to the development of non-food goods and services aimed at satisfying new needs as well as entering new markets or, alternatively, in the case of nonmarketable services, to provide community services in application of public contribution or contract.

Regrounding concerns managerial or ownership reorganization also turning to activities other than agriculture (for instance off-farm labour), but integrated at the household level.



Source: van der Ploeg et al. (2002)

Fig. 1 Multifunctional diversification: a graphical representation

Given the limited information provided by FADN on households, off-farm labour and other aspects implied by regrounding, here we only consider two directions of multifunctional diversification: deepening and broadening. According to definitions above and to the information provided by FADN on diversification activities, Table 1 details and classifies activities we include in the two mentioned groups.

The second modelling step entails the definition of a proper theoretical framework to analyze farm diversification strategies as rational choices. Here we follow the Random Utility Model (RUM) approach. Leaving details and more in-depth analysis to previous exhaustive surveys [15], we can simply adapt this framework to our specific circumstance as follows.

Table 1 Classification of activities identifying multifunctional diversification

Deepening	Broadening
Organic farming*	Agri-tourism
Product processing	Farm conctracting
Quality products (PDO, PGI, TSG)*	Participation to agri-environmental programs
ISO, HACCP certification*	
Other kinds of certification*	

* Data on organic farming and certification are not available for year 2000.

Let consider N farms observed over T years. Assume we can somehow measure the utility (e.g., profit or household income or other measures of farm performance or farmer's family satisfaction) of the i-th farm at time t (with $i = 1,\ldots, N$ and $t = 1,\ldots.T$), i.e. U_{it}.

This farm can choose among $M+1$ alternative farming strategies and we can associate to any j-th strategy (with $j = 0,\ldots, M$) its respective utility, U_{it}^{j}. The RUM assumes that decision-maker (namely, the farmer) has a perfect discrimination capability: whenever i-th farm at time t chooses the j-th alternative, the following always holds true:

$$U_{it}^{j} > U_{it}^{k}, \forall i = 1,\ldots N, \forall t = 1,..,T, \forall j,k = 0,\ldots M \quad (1)$$

According to the RUM, farmers always choose the alternative that gives them the highest utility. It evidently implies that diversification choices we actually observe always represent the optimal ones. We can not observe, however, farmer utility but only make hypotheses on (and observe) the ($1xP$) vector $\mathbf{X}_{it}$ of P utility determinants, that is, those farmer attributes, farm characteristics, as well as specific external conditions, affecting the unobserved utility. The linear utility model assumes that unobserved utility depends on these determinants as follows:

$$U_{it}^{j} = \mathbf{X}_{it}\boldsymbol{\beta}'_{j} + \varepsilon_{it}^{j} \quad (2)$$

where $\boldsymbol{\beta}_j$ is a ($1xP$) vector of parameters, specific for the j-th alternative, and ε_{it}^{j} is an error term expressing those unobservable variables eventually affecting actual utility. On the base of observable variables, $\mathbf{X}_{it}$, and of the observed actual farmer choices, we can derive a continuous variable $\Pr_{it}^{j}$ expressing the probability, or propensity, for i-th farm at time t to choose alternative j on the base of determinants $\mathbf{X}_{it}$:

$$\Pr_{it}^{j} = \Pr\left(U_{it}^{j} > U_{it}^{k}\right) = \Pr\left(\mathbf{X}_{it}\boldsymbol{\beta}'_{j} + \varepsilon_{it}^{j} > \mathbf{X}_{it}\boldsymbol{\beta}'_{k} + \varepsilon_{it}^{k}\right) = \quad (3)$$

$$= f\left(\mathbf{X}_{it}\boldsymbol{\beta}'_{j}, \mathbf{X}_{it}\boldsymbol{\beta}'_{k}\right)$$

$f(\cdot_k)$ in (3) can assume alternative forms, the largely most known cases leading to Logit and Probit models. Moreover, distinction is made between binary (or binomial) or multinomial models when alternatives are just two ($j = 0,1$) or more than two ($j = 0,\ldots,M$), respectively [15].

III THE EMPIRICAL MODEL

Application of RUM in (3) to multifunctional diversification choices discussed above can here take two forms. Firstly, we can simply admit two alternative choices, i.e, diversify (j=1) or not (j=0). Secondly, we can better detail diversification choices according to activities listed in Table 1, and admit four alternatives: not diversify (namely, to remain inside the "triangle" of conventional agriculture in Figure 1) (j=0), deepening (j=1a), broadening (j=1b), both deepening and broadening (j=1ab). In principle, we can then adopt four model specifications: Binomial and Multinomial probit and Logit. Logit is indeed more frequently used even because less computationally demanding [8], [10], [13], [15], though both models are often estimated in empirical applications [11], [12]. However, Multinomial Logit may incur in violation of the well-known hypothesis of Independence of Irrelevant Alternatives (IIA) [16]. As in the present case this hypothesis is in fact not accepted by data, only the Munltinomial Probit specification is adopted. On the contrary, following the prevailing orientation in empirical literature, the Logit specification is followed in the binomial case. The selection of determinants (vector $\mathbf{X}_{it}$ in (3)) depends on the information available in FADN but, among available variables, prevalence is given to those variables affecting the basic motivations eventually leading farmers to differentiate their activity in search of higher utility. According to empirical literature on farm diversification and multifunctionality, the most important factors concern: localization, personal motivation, and availability of production factors (mainly, physical and human capital), existence of a market for new outputs, strengthening the business for successors. Policy measures, too, may definitely play a role. However, we can only have information on actual policy support, given production choices of recipients, while we do not observe the policy support farmers could have received under alternative choices. Therefore, as we observe policy measures only after the choices are made, we can not treat them as independent variables, and include among determinants. Nonetheless, further investigation on this point will be proposed in section 5.

Table 2 describes determinants eventually included in the present analysis. As geographic variables, we consider the Province (*PROV*) where the farm is settled, and the average altitude (*ALT*) of the commune where the farm is localized. In terms of farmer personal attitudes and motivations, we consider his age (*AGE*) and the presence of successors permanently working on the farm (*SUCC*). For resource endowment, variables included are the utilized agricultural area (*UUA*), the number of tractors (*TRAT*) (indicating the degree of capitalization and mechanization of the farm) and the Standard Gross Margin (*SGM*), as proxy of the economic size of farms. A final variable is also considered, to express the idiosyncratic attitude toward diversification (*TF*). It is a qualitative variable assuming lower value for an highly specialized farm (i.e., monocoltural) and higher value for farms with multiple crop or livestock activities. Time dummies complete the set of model variables.

Table 2 Determinants of farm choices (X)

Variables	Title	Description
PROV	Provincia	From North to South: Pesaro-Urbino = 41, Ancona = 42, Macerata = 43, Ascoli Piceno= 44 (numbers express the respective ISTAT code of 4 provinces of Marche)
ALT	Altitude	Meters Height Above Sea Level
SUCC	Presence of descendants of the holder permanently occupied in the farm	Not present = 0, Present = 1
AGE	Farmer’s age	years
UUA	utilized agricultural area	
TRAT	Tractors in the farm	Not presence = 0 Presence= 1
SGM	Standard gross margin	Measured in Euro
TF	Type of farming per grounding	From 1 (=maximum specialization) to 8 (=maximum conventional diversification)
Dum1*	Dummy variables (time)	2000 = 1 other years = 0
Dum2*	Dummy variables (time)	2001 = 1 other years = 0
Dum3*	Dummy variables (time)	2002 = 1 other years = 0
Dum4*	Dummy variables (time)	2003 = 1 other years = 0
Dum5*	Dummy variables (time)	2004 = 1 other years = 0
Dum6*	Dummy variables (time)	2005 = 1 other years = 0
dumt**	Dummy variables (time)	2000-2002 = 0; 2003-2005=1

*dummies used in Multinomial Probit Model; ** dummy used in Panel Logit Models

IV DATA ISSUES: SAMPLING, MATCHING AND PANEL SPECIFICATIONS

A. Sample and matching

The analysis is here carried out on FADN farms of Marche region over years 2000-2005.

The study is limited to a single Italian region in order to maintain a certain degree of homogeneity in agricultural structures, characters and history. The choice of the Marche region depends on the fact that it is a region, as other Central Italian regions (e.g., Tuscany, Umbria), where multifunctional diversification is exalted on several aspects [17].

In principle, using the FADN allows to construct a balanced panel of farms over the six years of investigation. Nonetheless, the FADN survey design has changed during this period, as until 2002 the participation of farmers was on a voluntary basis, while from 2003 onwards farms were selected randomly to achieve greater statistic representativeness. The practical consequence of this change in the FADN sample is that we can only work on two different balanced panels of 387 farms: the first from 2000 to 2002, the second from 2003 to 2005. These two panels only partially overlap, therefore their combination generate a largely unbalanced panel.

To make use of this unbalanced panel within DCM, we thus undergo a matching procedure. This procedure mainly aims at matching any farm of the first panel with the most similar one of the second panel, evidently beside those farms actually present in both panels. The matching algorithm considers localization (PROV), physical dimension (*UUA*) and economic dimension (*SGM*)[1] and allows rebalancing the panel across the two periods: through a time dummy taking into account the shift of the panel occurred in 2003, the matching algorithm allows working on the six-year period with a "simulated" balanced panel of 387 observations.

B. Panel specifications

Extending conventional DCM to panel data may present specific complications [18]. In particular, estimation of the Multinomial Probit may be computationally challenging and identification of the farm-specific effects unaffordable. Therefore, the Multinomial Probit model is here estimated by simply pooling the data over the unbalanced panel, that is, by considering any record as an independent observation. On the contrary, the Binomial Logit can fully exploit the informative potential of the panel. In this case, however, two possible specifications are possible, as usual.

[1] On the base of these variables, the algorithm calculates the "distance" between any pair of farms from the two panels. Matching is thus achieved identifying the set of pairs that minimize the overall distance. Due to space limits, the algorithm is not reported in details here but is available upon request.

Let make the farm-specific effect, μ_i, explicit in (3). Writing $\varepsilon_{it} = u_{it} + \mu_i$, we can distinguish the case where μ_i is time-invariant and fixed (deterministic) (Fixed-Effects = FE) from the case where μ_i is time-invariant and random (stochastic) (Random-Effects).

In principle, the FE specification could seem more appropriate as farm-specific effects more realistically refer to permanent, structural or idiosyncratic characters. At the same time, however, estimation of the FE Binomial Logit can only be afforded if all observations show a change in the outcome variable over the time dimension. Otherwise, the time-invariant farm-specific effects can not be separately identified[2].

Therefore, we firstly estimate a RE Binomial Logit model and, then, a FE Binomial Logit over the subpanel sample of those farms that changed their choice (from non-diversified to diversified, or the other way round) at least once during the six-year period. For this sub-sample, in fact, the FE Logit model estimation can be regularly afforded [18], [19].

V. ESTIMATION RESULTS

A. Multnomial Probit

Table 3 reports parameter estimates of Multinomial Probit on pooled data. It must be firstly noticed that multifunctional diversification within the sample is prevalent, though not very homogeneously distributed across the three alternative options. Over the whole panel, farms are distributed among 4 choices as follows: 39% for *j = 0*,43% for *j = 1a*, 5% for *j = 1b*, 13% for *j = 1ab*., 61% of observations concern somehow diversified farms in multifunctional terms, though deepening largely prevail on broadening.

Firstly, we may appreciate that geographical location plays a role in diversification choices. On the one hand, a greater attitude toward

[2] We do not discuss, here, another typical estimation issue of FE Logit models, that is, the so-called incidental parameters problem. Readers may find details in Baltagi (2005, p. 209-215).

diversification emerges in the southern provinces of the region.

On the other hand, deepening is negatively linked to altitude, thus being less frequent among farms of mountainous areas. On the contrary, broadening and joint broadening-deepening are more frequent in mountainous territories, and this can be explained by the fact that participation to agro-environmental measures are granted with priority in mountain and hillside areas.

Among farmer specific characters, quite surprisingly, age positively influences farmers' choice to undertake deepening activities, but not the other two diversification choices. At the same time, it is also worth noticing that the presence of successors within the farms does not significantly influence diversification choices. These results would suggest that generational issues do not assume particular relevance in multifunctional farm diversification.

In terms of farm structural characters, the most interesting result is the negative effect of SGM. This could be interpreted by the fact that highly specialized farms are characterized by higher gross margin and thus may not find interesting to undertake a diversification strategy. This interpretation could be confirmed by the statistically significant positive sign assumed, with the exception of broadening, by parameter associated to TF indicating propensity to conventional farm diversification. Intuitively, the contemporaneous presence of several conventional activities gives an impulse also to multifunctional diversification, at least in terms of deepening.

Farm physical size does not seem to play a major role. In fact, UUA is statistical significant only in case of combination of deepening and broadening. Evidently, large-size farm assumes importance only in a multi-diversified context. Farm size in terms of physical capital endowment actually seems more important, as mechanization (TRAT) turns out to positively affect multifunctional diversification, in all forms, at 5% significance level.

A final noticeable result concern time dummies, as they are mostly statistically significant[3]. The larger impact is due to year 2003 dummy, that is, the year of the change in sample design. In addition, sign associated to these dummies is always positive, when significant, for deepening and negative for broadening. Evidently, the prevalence of deepening in farmer choices increased over the observed time period.

[3] To avoid singularity, year 2001 dummy has been dropped.

Table 3 - Multinomial Probit model estimates (j=0 is the reference outcome)

Variable	*j = 1a*	*j = 1b*	*j = 1ab*
Constant	- 1.358*** (0.239)	- 2.293*** (0.424)	- 2.265*** (0.298)
PROV	0.266*** (0.036)	0.347*** (0.063)	0.453*** (0.046)
ALT	-0.001*** (0.000)	0.002*** (0.000)	0.001*** (0.000)
SUCC	0.079 (0.151)	- 0.295 (0.289)	- 0.061 (0.196)
AGE	0.007*** (0.003)	- 0.009*** (0.005)	-0.017*** (0.004)
UUA	- 0.001 (0.002)	0.006 (0.004)	0.005*** (0.002)
TRAT	0.140*** (0.037)	0.212*** (0.068)	0.251*** (0.046)
SGM	- 0.001*** (0.000)	- 0.001*** (0.000)	- 0.001*** (0.000)
TF	0.066*** (0.018)	0.010 (0.033)	0.164*** (0.021)
dum1	-0.109 (0.135)	- 0.083 (0.175)	- 0.129 (0.177)
dum2	0.355*** (0.135)	- 0.506*** (0.204)	0.105 (0.177)
dum3	0.386*** (0.136)	- 1.320*** (0.301)	0.005 (0.176)
dum4	0.339*** (0.136)	- 1.499*** (0.340)	0.092 (0.174)
dum5	0.345*** (0.137)	- 1.141*** (0.273)	0.189 (0.172)

**, ***denotes statistical significance at 10% and 5% confidence level, respectively

B. Panel Logit

Table 4 displays estimates of the two panel Logit specifications. The results for panel RE are not so different from Multinomial Probit. Here, however, results refer to the binary choice and a positive sign of a parameter must be interpreted as diversification-inducing effect of the respective variable.

Table 4 – RE and FE Logit model estimates – standard errors in parenthesis

Variable	RE Logit	FE Logit (restricted)
Constant	- 2.183*** (0.415)	0.628*** (0.088)
PROV	0.575*** (0.064)	0.628*** (0.088)
ALT	- 0.010*** (0.000)	- 0.001*** (0.001)
SUCC	0.198 (0.266)	0.720** (0.393)
AGE	0.006 (0.005)	0.010 (0.007)
UUA	0.004 (0.003)	0.012** (0.007)
TRAT	0.363*** (0.063)	0.565*** (0.096)
SGM	- 0.001*** (0.000)	- 0.001*** (0.000)
TF	0.192*** (0.032)	0.255*** (0.047)
Dumt	0.186** (0.112)	0.449*** (0.139)

**, ***denotes statistical significance at 10% and 5% confidence level, respectively

Localization in the South and lower altitude are in favour of diversification, as well as mechanization and conventional diversification (TF), while larger gross margins seem to prevent farms from diversifying in multifunctional sense. As in Multinomial Probit, farmer age, presence of successors and farm size are not significant.

FE Logit estimation, as mentioned, can not be directly compared to previous estimates as it is applied to the restricted sample of 182 farms, instead of 387, for which we observe at least one change in diversification choice over the period. Nonetheless, coefficient significance and signs are in line with other models, and also their magnitude is in most case quite close to the RE Logit case. The only major difference indeed concerns the role of successors, whose presence now significantly and positively favours farm diversification.

In both panel model specifications the time dummy, identifying the shift in sampling from 2002 to 2003, is positive and statistically significant, particularly in the FE Logit case, thus suggesting an increasing attitude toward multifunctional diversification. It is not possible, however, to really detect how much of this effect is real and how much actually depends on the change in sampling. In fact, albeit parameter associated to this dummy is aimed at taking into account the change in sample, nonetheless this latter may still affect estimates unless we assume this change is fully captured by a constant shifter which is equal for all couples of farms. The matching procedure above discussed actually aims at making this assumption hold more strictly. After all, substantially convergent results obtained from pooled (Multinomial Probit) and panel estimations indicate that matching and introduction of the time dummy are both successful.

C. The role of I and II pillars of CAP

One conclusive concern on estimates previously discussed may inevitably deal with the role of policy measures and of the CAP, in particular. As mentioned, in FADN, available information on farm-level CAP payments do not allow identifying the role of such measures in inducing or preventing diversification.

Nonetheless, we can still correlate the observed CAP payments with results obtained from DCMs. In particular, from any of the three specifications, we can compute the predicted outcome, that is the propensity (or probability) associated to respective choices and attributable to any farm on the base of the estimated coefficients ($\boldsymbol{\beta}$) and of the observed independent variables ($\mathbf{X}_{it}$).

Table 5 reports the bivariate correlation coefficients between these predicted outcomes and the total CAP farm payments also distinguished in I and II pillar payments. For all model specifications, correlation is low (always lower than 0.2, the only exception being I pillar payments and predicted outcome of FE Logit) and in some cases not statistically different from 0 for II pillar payments. In general terms, there is no evidence of a positive and relevant correlation between multifunctional farm diversification and rural development policies; when significant, it is still quite low.

At the same time it may not be surprising to notice that I pillar payments are negatively correlated with diversification choices, and this can be attributed to the fact that these payments are still coupled to conventional agricultural activities in most observed years. In particular, the two panel estimates seem quite concordant in identifying a positive but very low correlation of diversification with II pillar payments, and a much more remarkable negative correlation with I pillar. This would suggest that, though we can not conclude that rural development measures actually provide a positive impulse to multifunctional diversification, the I pillar seems to be an obstacle to it. Nonetheless, when broadening is separated from deepening, as in Multinomial Probit, the vice versa holds true, as I pillar is positively and significantly correlated with this kind of diversification. The presence of farm contracting among broadening activities can partially explain this evidence.

Table 5 – Bivariate correlation between model predicted outcome (estimated Pr(.)) and CAP payments

Model	Total CAP payments	I pillar payments	II pillar payments
Multinomial Probit			
Pr(j=0)	0.0129	0.0219	-0.0180
Pr(j=1a)	-0,1417*	-0.1505	-0,0304
Pr(j=1b)	0.1080*	0.1203*	0.0091
Pr(j=1ab)	0.0884*	0.0812*	0.0514*
RE Logit: Pr(j=1)	-0.1907*	-0.1920*	-0.0679*
FE Logit: Pr(j=1)	- 0.1593*	-0.2613*	0.0508*

*denotes statistical significance at 5% confidence level

In any case, these results suggest that further more detailed and careful investigation on the role of CAP payments in inducing diversification are needed. More detailed data and, above all, larger panel datasets will allow more sophisticated analyses in this respect. It must be also noticed that the introduction of decoupled payments in the form of Single Farm Payments from 2005 onwards inevitably complicates the overall picture and the consequent analysis. This final issue is clearly beyond the scope of this paper, as only one year of application of the reform in Italy (i.e., 2005) is available in the dataset. However, it will definitely be on the forefront of future research on this topic.

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