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# **Investigating determinants of agricultural income diversification. An exploratory case study in Tuscany**

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## **Abstract**

This paper investigates on-farm income diversification determinants, using data from the Italian 2010 census. The determinants are investigated by simulating farmers' behaviors as a two-step process through the application of the Heckman sample selection model. Model results are quite consistent with previous literature findings and confirm the relevance of risk exposure reduction as on-farm diversification strategy determinants. Results stress also that, besides farm characteristics and structures, spatial location and distances play a prominent role in explaining the diversification process. Our results seem contrary to the demand-driven effects of diversification but stress that diversification could be considered a broader process driven by territorial potentiality and quality.

**Keywords:** Diversification; Heckman Model; Sample Selection; Tuscany

## **1. Introduction**

The aim of this paper is to investigate how farm/farmer and household (internal) and/or territorial (external) variables affect decisions about diversification. The adoption process is simulated as a two-step process: a) discrete choice between adoption and a non-diversification strategy and b) intensity of on-farm income diversification. A sample selection model is applied for the purpose of taking into account the double steps in decision making in the diversification process.

The theoretical basis of the diversification-adoption process is rooted in the farm household model (Mishra et al., 2004). Therefore, by allocating on-farm household labour, a generic farm household seeks to increase incomes through diversification or farm production intensification. Several papers explore motivation and determinants to diversify farm income. The greater part of those papers, applying the portfolio model, show that on-farm income diversification is pursued by risk adverse agents to reduce risk exposure and to stabilise the income stream (Anderson et al., 2003; McNamara and Weiss, 2005).

Within this framework, several authors use farmer and farm features to investigate determinants of the diversification-adoption process. For instance, McNamara and Weiss (2005), quoting rural sociology studies, found that young and old farmers are less likely to diversify due to the lower risk aversion for young farmers and the reduced workload for old farmers. McNamara and Weiss (2005) argue that an increasing farm size is more likely to result in on-farm income diversification, since the reduction of marginal returns drive a farm's resource allocation to more profitable activities.

Other authors have pointed out that household characteristics, such as family labour endowment, number of household components, and farmer and spouse education, have a relevant role in explaining diversification strategy (see, for example, Vik and McElween, 2008; Bowman and Zilberman 2013). Several authors have investigated the role of agricultural policy in affecting farmer behaviour toward diversification, explaining impacts of both first- and second-pillar payments on diversified strategies (Maye et al., 2009). On one hand the payments increase the overall sector profitability and the return from on-farm households labour allocation and promote on-farm investments (Bartolini et al., 2011), while on the other hand there are negative effects of first pillar policy on diversification due to the maintenance profitability of commodity crops through the promotion of intensification (Bowman and Zilberman 2013). Literature about the effects of the RDP policy show the positive effects of these payments towards on-farm income diversification by a co-funding mechanism for first- and third-axes payments (Bartolini and Viaggi, 2012).

A growing literature focuses on how spatial features and location affect diversification. In particular, several studies found demand-driven effects of space on diversification, where farmers closer to touristic sites or urban areas are more likely to diversify their production (Zasada, 2011) as a consequence of higher demand for farm services. Other studies found

opposite effects, pointing out that closeness to urban areas could increase off-farm opportunity (Mishra et al. 2010; Bartolini et al., 2014).

## 2. Method and materials

The farmer's behaviour concerning the diversification toward on-farm activities is simulated as a two-stage decision process. In the first step, the farmer decides whether to diversify his or her activities toward off-farm production, while during the second step the farmer selects the intensity of on-farm income-diversified activities.

The econometric analysis that jointly accounts for these two independent decisions is the Heckman two-stage model (Heckman, 1979). The equation to model the two levels of off-farm activities,  $Y$ , of the  $j$ -th farm is:

$$\begin{aligned} y_j &= X_j \beta + u_{1j} \text{ if } Z_j \gamma + u_{2j} > 0 \\ \text{otherwise } y_j &= 0 \end{aligned} \quad (1)$$

Where  $X$  and  $Z$  are column vector of exogenous parameters and  $u_1$  and  $u_2$  are random errors of the covariates. Conditions on the random errors are:

$$u_1 \sim N(0; \sigma); u_2 \sim N(0; \sigma); \text{corr}(u_1; u_2) = \rho \quad (2)$$

The statistics  $\lambda = \sigma \cdot \rho$  gives an estimate of the sample selection bias applying a simple OLS. Lambda is often called the hazard rate. The probit estimates of the participation equation are obtained as follow:

$$\Pr(y_j > 0 | Z_j) = \Phi(Z_j \gamma) \quad (3)$$

In the first stage, the maximum likelihood estimation generates the selection equation (3). Then, the probability to diversify is computed as follows:

$$m_j = \frac{\phi(Z_j \hat{\gamma})}{\Phi(Z_j \hat{\gamma})} \quad (4)$$

where  $\phi$  is the normal density and  $m_j$  is called the inverse Mills ratio.

In the second stage, the hazard rate is added as a variable to provide consistent estimates for the second-stage outcome equation for the degree of diversification. To control for potential heteroscedasticity across farmers, the robust Huber-White sandwich estimator is employed using bootstrapping. The dependent variable is the quota of revenues from on-farm diversified activities, which is considered a proxy of on-farm diversification intensity.

The list of the covariates is classified into 4 categories. The first category concerns the territorial/spatial determinants with dummy variables to check for altimetric zones corresponding to costal mountain, costal hill, internal hill and plain. Moreover, the Tuscany territory has been classified into 5 homogeneous zones of development/rurality: urban areas (poli\_urb), areas with density lower than 150 inhabitants per square km with very intensive productions (rur\_int), rural areas in transition (rur\_trans), declining rural areas (rur\_desc1) and rural areas with development problems (rur\_probsv). Finally, the Euclidean distance of the municipalities to the closest urban areas (distmin) is included as a proxy for diversified services demand. The second group concerns the farmer's characteristics: a dummy equal to one if the farmer is a male (male), aged less than 40 years (young) or aged more than 65 years (old), has an agricultural education (edu\_agr) or at least a degree (edu\_high), or is a part-time farmer (partime) who lives on the farm (live\_on). The third category is composed of variables describing the structure of the farms: a dummy equal to one if the farm is an individual farm (indiv) or has a potential successor (succ) has only household labour (hlab), uses informatics systems (inform), or has more than 50% of self-consumption (selfcons) of utilised agricultural

area (UAA) (uaa), a variable determined by ratio of UAA and total land (ruaa); and the number of plots (plots). The fourth category concerns the farming system, and it contains a dummy equal to one if the farm has arable crops (arable), fruit crops (fruit), or animal husbandry (anim). Finally, the last category is linked to policy. It is formed by three variables (axis1, axis2, axis3) related to the payment obtained from the RDP support for each axis.

The data comes from the 6<sup>th</sup> agricultural census (2010). Data on the rural development programme comes from administrative data of ARTEA (Regional Rural Payments Agency).

### 3. Results and discussion

Data shows a low rate of on-farm income diversified activities. Almost 90% of farms are involved exclusively in agricultural production, while only 10% of Tuscany farmers have adopted at least one diversified activity. However, this portion of farms show a quite high median rate of revenues from on-farm income diversification, about 40% of the total farm income. Figure 1a shows the spatial distribution of farms with on-farm diversification as a percentage of farms with at least one on-farm activity. Figure 1b show the intensity of the on-farm income diversification as average quota of earning from on-farm activities in the municipality.

Figure 1.

a) % farms with at least one on-farm activity    b) Intensity of diversification

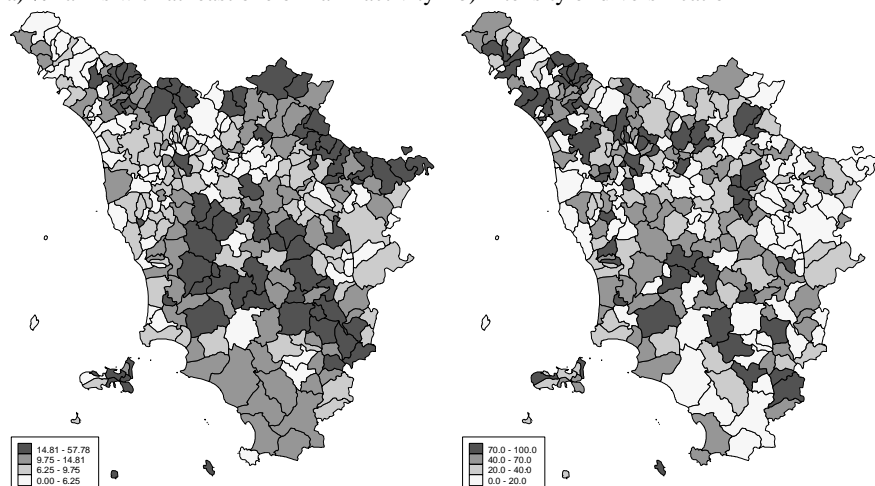


Figure 1 shows an uneven distribution of farmers with diversification activities across the Tuscany region. The results highlight the different spatial distributions between the share of farmers with diversified activities and the share of income generated by the on-farm income diversification. Table 1 shows the Heckman model results. The significant coefficient for the hazard rate ( $\lambda$ ) indicates the existence of selection bias and, thus, that the use of the Heckman model is justified. Hence, the model shows an underlying process that links the decision to diversify and second stage of choice with the intensity of on-farm income diversification. Results of the selection stage show that distance to the main urban areas is highly significant and shows a positive sign. Thus, increasing the distance from urban areas is more likely to result in a farmer's involvement in on-farm activities. *Inter alia*, by increasing the distance to urban areas by about 10 km, there is a 2% growth in the probability of observing a diversification of activities. Such results seem to oppose previous findings about the demand-driven effects of diversification while they are consistent with the hypothesis that farmers closer to urban areas allocate more labour off-farm or develop intensification strategies (McNamara and Weiss, 2005; Mishra et al., 2010). In fact, among those farms located in peri-urban areas, there is a higher expected off-farm income compared with that of remote areas (Mishra et al., 2010).

Results show that farms located in plain areas are less likely to diversify as a consequence of lower production costs (due to farm structure) and a high demand for intensification due to a higher return of scale. As a result, location in the plain has the effect of increasing the farm household labour mobility, and then there is a positive effect on off-farm labour allocation. The subdivision of the territory into zones has a positive and significant impact on diversification. Results show that in marginal areas the probability of diversifying is higher. A Wald test on parameters shows no difference among the several zones. Finally, results show that part-time farmers with a lower labour supply are less inclined to diversify.

Table 1: Empirical results

Group	Variables	Level equation		Selection equation	
		Coefficients	Bootstr. Std. Err.	Coefficients	Bootstr. Std. Err.
Territory	Intercept	43.16 ***	6.52	-1.5577 ***	0.0380
	Distmin	-0.06	0.03	0.002 ***	0.008
	Costal mountain	-2.51	3.69	0.12	0.07
	Internal Hill	-6.54 **	2.38	0.08	0.04
	Costal Hill	-6.39 **	2.99	0.05	0.04
	Plain	-2.50	2.36	0.23 ***	0.04
	rur_int	4.60 ***	1.86	0.01	0.03
	rur_tran	2.39	1.81	0.20 ***	0.03
	rur_decl	3.57 **	2.01	0.33 ***	0.03
	rur_probsv	1.46	2.55	0.43 ***	0.05
	Partime			-0.44 ***	0.02
Farmer features	Young	-0.32	0.98		
	Old	1.75 **	0.82		
	edu_high	2.60 ***	0.74		
	edu_agr	-3.63 ***	1.13		
	Male	-3.44 ***	0.74		
Farm features	Indiv	-12.45 ***	1.61		
	Uaa	-0.06 ***	0.02		
	Ruaa	-9.34 ***	1.33		
	Selfcons	18.95 ***	1.04		
Policy	axis1	-0.00004 **	0.00		
	Mills ( $\lambda$ )	12.26 ***	3.11		
	Rho	0.41			
	Sigma	30.09			
	Number of obs.	= 72,686			
	Selection equation	= 65,578			
	Outcome equation	= 7,108			
	Heckman Model Chi-Square	= 2048.24***			

Legend: \*\* p<.05; \*\*\* p<.01 (not significant variables are omitted)

The level equation includes only those farmers who have at least one on-farm income diversified activity. Distance to urban areas falls short of statistical significance. Thus, once farms diversify, the distance is not crucial for determining the level of commitment in on-farm activities. However, location in the hills shows a negative effect on the expected amount of diversification intensity compared with the higher altitudes. Smaller farms, in terms of UAA, with a higher orientation toward self-consumption conducted by an aging female farmer with a high level of education are likely to increase their revenues from on-farm income diversification. Results are consistent with literature results pointing out that less wealthy farms have a higher risk aversion. Surprising results are observed by RDP effects on intensity of diversification (Bartolini et al., 2014). Indeed, only the first axis of RDP payments (competitiveness) has a weak and negative effects on diversification intensity, while the specific measures of diversification are ineffective. Such results do not follow previous literature findings (Bartolini and Viaggi 2012) regarding the positive effects of RPD.

#### 4. Conclusions

On-farm diversification strategy, as well as the household labour off-farm allocation and intensification, which are the main strategies, represents a relevant option for increasing farm income or stabilizing income streams. The results of the model confirm that an on-farm diversification strategy is mainly adopted to reduce risk exposure.

In general, the vulnerable farms tend to enlarge their portfolio activities towards on-farm diversification. Indeed, farmers and farm characteristics are relevant variables against which to explain pluriactivity. The territorial characteristics are crucial variables in explaining on-farm diversification. The analysis of these variables confirms that the worst geographical conditions increase the likelihood to diversify. While the results seem contrary to the demand-driven effect of diversification, at the same time they show very heterogeneous behaviour among farmers who are alternatively spatially located.

Results show a weak effect of the policy in promoting on-farm diversification. Despite great emphasis on RDP policies, our finding reveals the trivial effects of these policies in promoting diversification. The results indicate that there is a need to develop a new policy instrument aimed at boosting territorial development rather than promoting sector development.

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