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Determinants of Structural Change in the agricultural sector: An Empirical Analysis of Farm Exit in Tuscany

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Summary

In the last decade Italy has experienced a consistent decline in the number of agricultural firms. Beyond the new definition of agricultural firms, this structural change of farms is characterized by exit of small farms and increasing farm size. This paper aims at analyzing the determinants of the net exit of Tuscan farms from the market during the period 2000 - 2007 both at the farm and the territorial level. The study combines data from two different sources: the 2000 census of Agriculture and three waves (2003 - 2005 - 2007) of the European "Farm and Structure Surveys" (FSS) realized in Italy by ISTAT (the National Institute of Statistics) . The resulting sample of Tuscan farms amounts approximately to 3000 agricultural firms. The exit probability of Tuscan farms from the market is estimated trough a bayesian hierarchical probit model where the group level coefficients correspond to the Local Labour Systems (LLS) i.e. a set of neighboring municipalities in which people live and work. Several variables related to farm, family, and geographical characteristics of the area are used as independent variables to investigate their net effect on the decision to exit. Results show that, among others, farm size, age of the farm operator, type of the holding have played a key role on exit. On one hand, higher farm size and professional nature of the activity lower the probability of exit. On the other hand, exit probabilities are higher for farms in which the farm operator is older nearer to retirement and without young members in his family that can replace him. Likelihood of exit is higher in areas (LLS) characterized by higher population density as the land use competition and possibly the richer labour market associated to these areas increases the exit behaviour. However given the same population density, exit probability is lower in "urban" LLS perhaps because of the proximity to remunerative market outlets for farm products.

Keywords: farm exit, hierarchical probit model, farms and territorial data
JEL Classification codes: Q12, Q18, C5, R14

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1. INTRODUCTION

In the last decade European Union has experienced a consistent decline in the number of agricultural firms. In Italy the net exit rate amounts to 32%. Especially in Tuscany the number of farms has decreased from 121,177 in 2000 to 72,686 in 2010 with a decline estimated to be 38% (ISTAT, 2012). This structural change of farms affects the management of land property, the amount of government payments, the management of abandoned land, the retaining of the population in rural areas, the reallocation of land and labor among the remaining farms or towards other economic activities. Understanding the exit decision is a key issue in designing agricultural policy, asking for increasing attention by researchers and policy makers.

In order to analyze the structural change of the agricultural sector two main categories of models emerge from the literature: econometric models and simulation models (for a review see Zimmerman at al., 2010). The latter ones include a bottom up perspective where interactions among agents can be modeled explicitly by the researcher. However in order to analyze the factors actually affecting the exit behavior most of the literature uses an econometric framework as it allows some sort of statistical validation of results.

Among all the available econometric approaches the Markov chain models are commonly used to determine the probability of farm's movements among farm types over time (transition probabilities) as result of a stochastic process (Zepeda, 1995, Rahelizatovo and Gillepsie, 1999, Stokes, 2006, Piet, 2008). Zepeda (1995) and Stokes (2006) apply a Markov model to analyze the effect of exogenous factors on the future entry/exit in the dairy sector respectively of Winsconsin and Pennsylvania. Results show that prices, interest rates, debt, land value drought and dairy termination programs affect the exit behavior.

Other econometric models are characterized by a regression analysis on different explanatory variables. In this framework stochastic models, built as a variant of Gibrat's law[1], are often used. Most of these models rejecting Gibrat's law, support the view that farm size is not determined by random factors (Shapiro et al., 1987, Weiss, 1999, Sumner and Leiby, 1987, Kostov et al., 2005, Dolev and Kihmi, 2010).

[1] Gibrat's law states that the size of a farm and its grow rate are independent so we should observe the same transition probability to larger farm both in small and large farms. For a rejection of the law applied to Tuscan farms between the 2000 and 2010 censuses see Stefani (2012).

Two different types of data can be used to analyze the exit behavior: micro-data at the farm level (Hoppe and Korbe, 2006, Stokes, 2006, Mishra et al., 2010) and macro-data at the area level (Goetz and Debertin, 2001, Breustedt and Glauben, 2007). Hoppe and Korb, (2006), using the 1997 census of agricultural longitudinal data set, investigate the US exit behavior over the period 1978-1997 through a logistic regression on micro data. Results show that the farms exit in different classes of sales and age of the farm operator, is negatively affected by the economic size and positively affected by the age of the farm operator.

A different way to classify the existing contributions is the use of ex post or ex ante data set (Mishra et al., 2010, Zepeda, 1995, Stokes, 2006). Mishra et al., (2010) investigate the intention of exit through a logit model applied to US and EU. Results show that some differences among the two countries exist. Education and having a successor are the main drivers to avoid the exit in the US, while structural characteristics of the farm and the family are the main factors influencing the exit in the EU.

According to the existing literature the main drivers of farms exit are the farm-support programmes, the profitability of farming, the human capital and the off-farm job opportunities (Piet et al., 2011). Most papers state that larger farms and younger farm operators are associated to lower probability of exits (Mishra et al., 2010, Hoppe and Korb, 2006, Glauben et al., 2006, Shapiro et al., 1987).The farm size is measured by UAA hectares (as in Bakucs et al., 2010, Hoppe and Korb, 2006), or by areas with permanent crops or livestock number (as in Zepeda, 1995, Foltz, 2004).

The human capital is another widely used variable to investigate the exit of farms especially the age and the education of the farm operator. They negatively affect the decision to exit for younger ages and high level of education (Mishra et al., 2010, Glauben et al., 2006). Glauben et al., (2006) confirm this statement investigating the decline of farm numbers in 326 counties of Western Germany between 1991 and 1999 trough two different OLS regressions: including all counties and excluding city counties. Results show that non-farm economy characteristics are not significant.

The profitability of farming, usually measured by the output/input prices, price ratio, gross sales, total gross margins or net income (Zepeda, 1995, Foltz, 2004, Breusted and Glauben, 2007, Mann and Mante, 2004, Dolev and Kihmi, 2010), negatively affects the exit. Mann and Mante, (2004) compare the factors affecting exit in agriculture and butchery sectors during the period 1982 and 2001 in Switzerland. Through a weighed least square regression model, the authors argue that the determinants of exit differ considerably between the two sectors. While for butchers the more relevant variable decreasing the exit is net profit, for farmers is the output price. However high interest rates lead to business failure in both sectors.

Other authors are specifically interested in the farm-support programs which seems to be negatively related to the exit probability. (Breusted and Glauben, 2007, Piet et al., 2011, Glauben et al., 2006). Piet et al. (2011) investigated the farm size inequality in France over the period 1970-2007, using as measure of this structural change the Gini coefficient of the size distribution. Results show that the farm support programs has decreased the farm size inequality. Following a different approach Ahearn et al., (2005) analyze the annualized exit rate between previous and current censuses (1982-1996) through a three stages least squares model which incorporate cross-equation correlation of disturbance. The authors show that commodity payments increase the exit rate of all farms as farmers receiving the payments are likely to expand their farm size buying out non-recipients or less productive farmers.

Finally another explanatory variable is found in the off-farm job opportunities which still has an ambiguous sign. Breustedt and Glauben, (2007), Mann and Mante, (2004) investigating the determinants of exits respectively in the Western Europe and in Switzerland show that part time farming reduce the exit rate. Similarly Kimhi and Bollman, (1999) and Kimhi, (2000) argue that the off-farm work decreases the probability of exit. Conversely Weiss, (1999) analyzing a panel of 50000 farms in upper Austria show that part time farming positively affect the exit probability. Even Goetz and Debertin, (2001), analyzing county level data related to US, show that the off-farm work accelerates the exit behavior when the county has already shown losses in the number of farms. Mishra et al., (2010) show that the effect of part time farming on the probability of exit is positive in US and negative in the EU.

This paper aims at investigating the exit of Tuscan farms from the market during the period 2000 - 2007 and the factors that may have affected this choice. Our analysis contributes to the literature focusing on non-farm characteristics, such as the population density and the geographical characteristics of the area (mountain vs. plain, urban vs. rural). These external variables are related to the use of land, as farmlands in urban area with higher population density are commonly subject to competition for alternative uses. However, proximity to urban markets might be a disincentive to farm exit. According to the literature the exit rate associated to lower transaction costs of entering in non-farm activity in areas with higher population density, seems to increase (Goetz and Debertin, 2001). Nyamadi and Shimomura, (1995) and Goetz and Debertin, (2001) using respectively an econometric cross section model with different groups of explanatory variables and macro data at county level, show that a higher population density or proximity to urbanization center positively affect the exit behavior. Conversely Glauben et al., (2006) studying the regional differences in the exit behavior of West Germany farms over the period 1991-1999, argues that population density decrease the exit rates which diverge among regions. According to the authors this result is due to the higher structural change of urban areas occurred in the past.

This paper provide a new analysis of the intertwining of farm and area level determinants of farm exit. Differently from previous works which were based on separate farm and county models we approach the analysis within a single hierarchical or multilevel model where the exit probability is explained both at the farm level and at the territorial level respectively by individual and group regressors.. In the Tuscan rural context, so diversified and spatially heterogeneous, this approach seems the only one capable to fully account for the structural dynamic processes ongoing. Notably, the probability of exit is estimated through a bayesian hierarchical probit model which take into account the structural differences among individual farms as well as the differences among different areas. Some explanatory variables are related to the characteristics of the farm (standard gross margin, livestock unit, type of farm business, etc) and the household (age of the farm operator, family members working on the farm etc) characteristics; other variables (population density and urban type) refer to the characteristics of the Local Labour Systems (LLS) i.e. a sets of neighboring municipalities within which people live and commute to work.

The paper is structured as follow: sections 2 describes the methodology used to investigate the farm exit in Tuscany. Section 3 provides a detailed description of the data, section 4 presents the empirical results and section 5 supplies some final remarks.

2. METHODOLOGY

We estimated a hierarchical probit model to investigate the exit behaviour in Tuscany over the period 2000-2007. The Bayesian model is based on a latent data formulation:

$$y_i = \begin{cases} = 0 & z_i < 0 \\ = 1 & z_i \geq 0 \end{cases} \qquad \text{for i= 1, n} \tag{1}$$

$$z_i \sim N(\boldsymbol{\beta}' \mathbf{x}_i + \alpha^{SLL}_{j[i]}, \quad 1) \tag{2}$$

$$\alpha^{SLL}_{j[i]} \sim N(\gamma^{urban} \cdot urban + \gamma^{dens} \cdot dens, \sigma^2_{SLL}) \qquad \text{for j=1,..,57} \tag{3}$$

Where: y_i is a dummy for exit of the farm; $\boldsymbol{\beta}$ is a vector of coefficients at farm (or individual) level, $\mathbf{x}_i$ is a vector of farm characteristics, the α_j are the group level coefficients, γ^{urban} and γ^{dens} are group level coefficients multiplied by the respective variables defined over the group level (that is at the LLS level) and σ_{SLL} is the unexplained standard deviation at group level.

A hierarchical model assumes that the group level coefficients are drawn from the common distribution (3) whose mean in turn depends on group level variables. Hierarchical parameter estimates may be seen as a weighted average of pooling and no pooling estimates. The former would be obtained by fitting a single probit model for all data, the latter by fitting a model with 57 dummy group (LLS) variables. The degree of partial pooling is a function of the group level errors, the smaller the error the larger the pooling (Gelman and Hill, 2007, ch. 14).

We employed the following non informative priors on vectors, β, γ and on σ_{SLL}:

$$\underline{\boldsymbol{\beta}} \sim N\left(\mathbf{0}, \mathbf{I} \cdot 100^2\right) \quad \underline{\boldsymbol{\gamma}} \sim N\left(\mathbf{0}, \mathbf{I} \cdot 100^2\right) \quad \underline{\sigma_{SLL}} \sim Half - Cauchy(25) \tag{4}$$

Noninformativeness for β and γ is obtained by imposing a large variance to their prior distributions. To the same purpose we choose the Half Cauchy (25) prior for variance parameters consistently with the recommendations given by Gelman, (2006). The Bayesian model was estimated using Markov Chain Montecarlo Methods as implemented in WINBUGS (Lunn et al., 2000; Sturtz, Ligges and Gelman, 2005). This software uses a Gibb sampler that simulates the full conditionals distribution of the vector of parameters θ. That is, the distributions of each parameter conditional upon the data (**X**) and all other parameters given by:

$$p\left(\theta_i \mid \{\theta_j, j \neq i\}, \mathbf{X}\right) \tag{5}$$

The Markov chain produced by the sampler has a stationary distribution equals to the joint posterior distribution of θ (Gelman et al., 2004). This simulation method is commonly employed when it is difficult to sample directly from the marginal posterior density, but it is easier to sample from the conditional distributions of the individual parameters as in the case of hierarchical models. We run the WINBUGS simulation with 3 chains, and 10,000 iterations (with a burn in of 5.000). Convergence of the iterations is maintained when the potential scale reduction factor R-hat is close to 1 (Gelman et al., 2004).

3. DATA AND MODEL SPECIFICATION

3.1. Data

This study combines data from the 2000 Census and from samples of the “Farm Structure Survey” (FSS) carried out by Istat in three different years (2003 - 2005 - 2007). The way FSS are designed allows the researcher to follow the structural evolution (entry, exit, restructuring) of a sub-sample of farms along the considered period while the Census database provides information on the initial characteristics of farms included in the sub-sample. A farm existing at the beginning (2000) and at the end (2007) of the investigated period, is considered as a *survivor*.

According to our definition a farm exits the industry when it no longer exists at the date of the surveys following the Census because either land has been allocated to non agricultural uses or land has been abandoned (fallow lands) or husbandry activity has ceased. In the analysis we distinguish between *exit* and *restructuring* of farms.We do not consider as exit the splitting of the farm in several new units or its merging in a larger unit. Furthermore, the changing control over a given farm does not implies exit, as the data follow the farm rather than the operator (for example in the case of a change in the operator among relatives).

The resulting sample of Tuscan farms is composed by 3,187 agricultural firms which were operating in 2000. Comparing the selected sample with the totality of farms surveyed on 2000 we can observe higher mean UAA, implying that larger farms are more likely to be included in the sample (see table 1). Over the period 2000-2007, the number of farms included in the selected sample declined almost by 15% as the number of exits amounts to 467. Conversely the average size increased from 39.72 hectares of the initial sample to 46.94 hectares of the survived farms.

Table 1. Comparison the 2000 Census and the selected sample

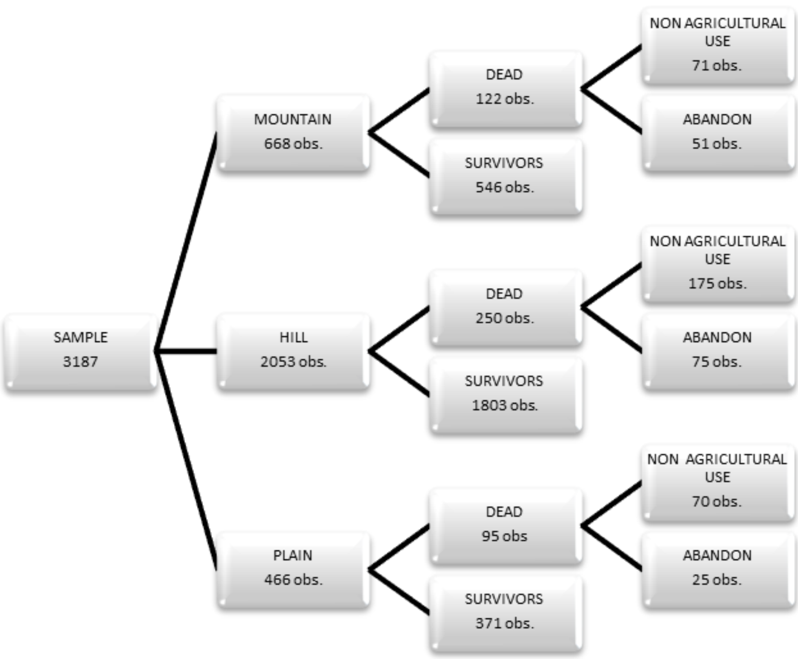
	UAA hectares		Total hectares		Rented hectares		UBA		Age of the FO	
	2000 census	sample	2000 census	sample	2000 census	sample	2000 census	sample	2000 census	sample
MIN	0	0	0	0.03	0	0	0	0	<20	<20
1ST QUART	0.35	0.86	0.63	1.43	0	0	0	0	51	46
MEDIAN	1	3.71	1.84	6.10	0	0	0	0	61	58
MEAN	6.132	39.76	11.64	71.18	1.63	14.54	1.32	12.82	60	57
3RD QUART	3.47	19.38	6	29.02	0	0	0	0	71	67
MAX	1834	1105	11180	2725	2725	2725	1831	1831	>90	>90

Source: own elaboration on 2000 Census and FSS data

The farm level data have been merged with the local labor system (LLS) data. containing information on 57 different homogeneous areas of Tuscany composed by several neighboring municipalities within which people live and commute to work. We used LLS as they seem to be a proper area definition to investigate the influence of the local socio-economic system on farm exit behavior.

Dividing the selected sample by three different level of altitudes (mountain, hill and plain) we note that the hill altitude collects the highest number of observations which is equal to 2053, followed by the mountain altitude containing 668 farms and the plain level with 466 agricultural firms. Figure 1 illustrate the number of exit in these three different levels of altitudes. Hill area with 250 exits show an exit rate of 7.8%, whilst in mountain and plain areas the exit rates are respectively equal to 3.8% and 3.0%.

Figure 1: Structure of the selected sample according the altitude level



Source: own elaboration on 2000 Census and FSS data

As showed by table 2, the exits over the investigated period seem to show a consistently lower average size at every level of altitude with a mean value varying from 1.6 hectares in plain areas to 3.74 hectares at hill areas. The survived farms show an average size included between 23.04 hectares in mountain areas and 57.29 hectares in hill areas.

Table 2. UAA hectares according to altitude and surviving

	MOUNTAIN		HILL		PLAIN		TOTAL	
	DIED	SURV.	DIED	SURV.	DIED	SURV.	DIED	SURV.
MIN	0	0	0	0	0.05	0	0	0
1ST QUART	0.17	0.8	0.28	1.82	0.19	0.68	0.21	1.28
MEDIAN	0.49	3.0	0.69	8.06	0.38	2.16	0.5	5.5
MEAN	2.17	23.04	3.74	57.29	1.6	25.47	2.92	46.08
3RD QUART	1.4	13.00	1.7	34.22	0.84	8.81	1.4	24.99
MAX	42.35	575.7	313	1104	34.31	1105	313	1105

Source: own elaboration on 2000 Census and FSS data

Splitting the selected sample by physical size (classes of UAA) we observe that smaller farms show a consistently higher exit rate (table 3); the subset of farms smaller than 5 hectares records almost 92% of the total exits The higher exit rate within the class of small farms is registered in plain areas (27% against an average 25% for the small farms group).

Table 3. Structure of the sample divided by classes

CLASSES(HA)	OBSERVATIONS	EXITS	EXIT RATES
0-5	1749	431	0.25
- mountain	442	110	0.25
-hill	970	231	0.24
- plain	337	90	0.27
5-10	348	14	0.04
- mountain	71	6	0.08
-hill	239	6	0.03
- plain	88	2	0.02
10-50	628	19	0.03
- mountain	100	6	0.06
-hill	471	10	0.02
-plain	57	3	0.05
50-200	253	2	0.01
- mountain	191	0	0.00
-hill	21	2	0.10
-plain	14	0	0.00
>200	209	1	0.00
-mountain	14	0	0.00
-hill	182	1	0.01
- plain	13	0	0.00

Source: Own elaboration on 2000 Census and FSS data

3.2. Model specification

We dealt with the two layer of factors explaining the probability of exit – the farm level and the territorial level- with a hierarchical probit model splitting the sample in 57 groups corresponding to Local Labour Systems (SLL) i.e. the group level coefficients that includes at least one Tuscan municipality. The dependent variable, i.e. the farm exit, is a dummy equal to 1 when the farm exits the industry during the period and 0 otherwise.

Following the hierarchical nature of the model different independent variables are identified at the farm and the SLL level (see table 4).

Table 4. Descriptive statistics for Tuscan farms

Variable	Definition		Mean	Std. Dev.	Min.	Max.
exit1	Number of exit	binary 1= dead, 0= survivor	0.15	0.35	0	1
rls	Standard Gross Margin	continuous	69,929	20,2345	0	372,5461
uba_1	Livestock Units	Binary =1 livestock>5, =0 otherwise	0.15	0.36	0	1
eta	Farm Operator age	continuous	56.86	14.64	16	97
d_young	young Household member (i.e. aged under 45) working in the farm	binary 1= At least 1 young working member, 0= otherwise	0.043	0.33	0	1
adesione	Producer Associations (PA)	Binary 1= in a PA, 0= out of PA	0.35	0.48	0	1
abit_occ_fam	Farm housing	Binary 1= family living in the farm, 0= otherwise	0.52	0.50	0	1
ist	Corporation holding	binary	0.07	0.26	0	1
profft	Professional full time holding	binary	0.14	0.35	0	1
profpt	Professional part time holding	binary	0.31	0.46	0	1
Pop_dens_sll	SLL population density	continuous	200.37	179.77	18.02	861.62
urban	SLL urban	Binary =1 SLL urban, 0= otherwise	0.20	0.40	0	1

Source: Own elaboration

The first variable is a proxy of farming added value. At the farm level the standard gross margin variables is calculated assigning a standard value to each UAA hectare according to its use and to each livestock unit by type. *Uba_1* is a dummy variable depending on the number and the variety of the livestock in the farm. These variables are proxy of the economic size of the farm. *Eta* is the age of the farm operator in 2000 and *d_young* measures the presence of young household members working in the farm. The hypothesis is that farms with a younger farm operator and other young household working members in the farm have a lower attitude to exit. *Adesione* is a dummy variable taking into account the fact that the farm is member of producers associations. We expect that farm belonging to a network of actors seeking to give value to the local resources should show lower probability of exit. *abit_occ_fam* is a dummy equal 1 when the family lives in the farm and 0 otherwise. Then we include a set of dummies to characterize the type of agricultural holdings. Besides non family run holdings (that is corporations or other legal entities) we distinguish between professional and non professional household holdings depending on whether the Standard Gross Margin, measured following EU methodology, is larger than 6 ESU, a floor compatible with the remuneration of a full time unit of labour. Within professional holdings full time ones are those with at least one family member working more than 180 days in a year[2]. Finally at the SLL level *pop_dens _sll* measures the SLL population density while *urban* defines the urban SLLs according with the ISTAT classification. Both are expected to negatively affect the farm surviving.

4. RESULTS

The results of the hierarchical probit model are illustrated in tables 5 and 6 and in figures 2 and 3.. At the farm level the estimated coefficients confirm the findings of the existing literature. Higher standard gross margin and livestock number seem to decrease the probability of exit. Conversely a higher age of the farm operator increase the probability of exit. Being members of producers association, living in the farm, and having household members younger than 45 years old working on farm negatively affect the exit behaviour. Conversely the mountain altitude shows an unexpected sign, negatively affecting the exit.

The SLL coefficients are estimated from a distributions with mean depending on population density and urban type of the SLL. Higher population density positively affect the exit behaviour. Actually, the population density can be seen as a proxy of competition between civil and agricultural uses of the land.

[2] For a detailed account of the classification and its relationship with farm integration in the product and factor markets see Rocchi and Stefani (2004)

Table 5. Estimated coefficient posterior distributions statistics

	Mean	Std. Dev	Q(0.025)	Q(0.50)	Q(0.975)	Naive SE	Time Ser. SE	Gelman's R
Individual								
Intercept	-0,73	0,13	-0,99	-0,73	-0,48	0,00	0,01	1,00
Standard Gross Margin	-0,07	0,02	-0,10	-0,07	-0,03	0,00	0,00	1,01
Livestock Units	-0,58	0,20	-1,02	-0,58	-0,22	0,01	0,01	1,01
Farm Operator age	0,08	0,02	0,03	0,08	0,12	0,00	0,00	1,00
Young Household members	-0,25	0,13	-0,52	-0,24	-0,01	0,00	0,00	1,00
Producer Associations	-0,37	0,09	-0,55	-0,37	-0,19	0,00	0,00	1,00
Farm housing	-0,12	0,02	-0,16	-0,12	-0,08	0,00	0,00	1,00
Mountain	-0,22	0,07	-0,35	-0,22	-0,08	0,00	0,00	1,00
non family farm	-0,37	0,09	-0,55	-0,37	-0,19	0,00	0,00	1,00
professional full time	-0,20	0,07	-0,33	-0,20	-0,07	0,00	0,00	1,00
professional part time	-0,26	0,12	-0,52	-0,25	-0,03	0,00	0,00	1,00
Group								
SLL population density	-0,30	0,21	-0,75	-0,30	0,11	0,01	0,01	1,00
Urban SLL	-0,52	0,19	-0,91	-0,52	-0,18	0,01	0,01	1,00
SLL coef standard deviation	-0,47	0,11	-0,68	-0,47	-0,25	0,00	0,00	1,00
Residual Deviance	2028,9631	12,788514	2006	2028	2056	0,40	0,50	1,00

Source: own elaboration

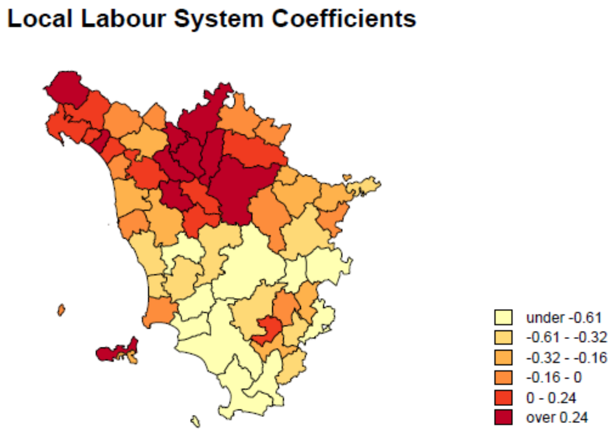
Table 6 and figure 2 shows that the farms located in the north of Tuscany are associated to a higher probability of exit. Actually, these SLL represent one of the areas of Tuscany where the population density is higher. Conversely farms located in the south of Tuscany, characterized by a lower population density and rural areas with a competitive wine industry, are more likely to survive. .

Table 6. SLL coefficients (α_j)

den_LLS	Cod_LLS	Mean	SD	Gelman's r	den_LLS	Cod_LLS	Mean	SD	Gelman's r
La Spezia *	191	0,15	0,35	1,00	Volterra *	262	-0,69	0,42	1,00
Pievepelago	210	-0,15	0,41	1,00	Arezzo	263	-0,61	0,19	1,00
Gaggio Montano	214	0,58	0,41	1,00	Bibbiena	264	-0,18	0,31	1,00
Aulla	234	0,10	0,17	1,00	Cortona	265	-0,70	0,24	1,00
Carrara *	235	0,19	0,39	1,00	Montevarchi	266	-0,03	0,17	1,00
Massa *	236	0,82	0,26	1,00	Pieve Santo Stefano	267	-0,28	0,37	1,00
Pontremoli	237	0,24	0,18	1,00	Pratovecchio	268	-0,18	0,40	1,00
Barga	238	-0,19	0,23	1,00	Sansepolcro	269	-0,15	0,28	1,00
Castelnuovo Di Garfagnana	239	-0,08	0,21	1,00	Chiusi	270	-0,69	0,31	1,00
Lucca	240	0,23	0,15	1,00	Montalcino	271	-0,50	0,32	1,00
Pietrasanta	241	0,13	0,22	1,00	Montepulciano	272	-0,31	0,27	1,00
Viareggio *	242	-0,16	0,20	1,00	Piancastagnaio	273	-0,49	0,42	1,00
Montecatini-Terme	243	0,74	0,15	1,00	Poggibonsi	274	-0,55	0,26	1,01
Pistoia	244	0,42	0,16	1,00	San Quirico D'orcia	275	-0,14	0,35	1,00
San Marcello Pistoiese	245	1,04	0,32	1,00	Siena *	276	-0,61	0,25	1,00
Borgo San Lorenzo	246	0,12	0,23	1,01	Sinalunga	277	-0,68	0,26	1,00
Castelfiorentino	247	0,03	0,24	1,00	Castel Del Piano	278	0,07	0,30	1,00
Empoli	248	0,03	0,20	1,00	Follonica	279	-0,61	0,31	1,00
Firenze *	249	0,34	0,16	1,00	Grosseto *	280	-0,85	0,27	1,00
Firenzuola	250	-0,13	0,39	1,00	Manciano	281	-0,65	0,40	1,00
Marradi	251	-0,01	0,39	1,00	Massa Marittima	282	-0,78	0,37	1,00
Castagneto Carducci	252	-0,43	0,28	1,00	Orbetello	283	-0,66	0,32	1,01
Cecina	253	-0,35	0,21	1,00	Pitigliano	284	-0,36	0,30	1,00
Livorno *	254	-0,10	0,27	1,00	Santa Fiora	285	-0,26	0,37	1,00
Piombino	255	-0,11	0,22	1,00	Prato	286	0,46	0,17	1,00
Porto Azzurro	256	-0,29	0,43	1,00	Piandimeleto	309	-0,34	0,43	1,00
Portoferraio	257	0,68	0,34	1,00					
Pisa *	258	-0,25	0,20	1,00					
Pomarance	259	-0,35	0,32	1,00					
Pontedera	260	-0,24	0,18	1,00	Sigma (αj)		0.43	0.09	1,00
Santa Croce Sull'arno	261	0,24	0,18	1,00					

Source: own elaboration

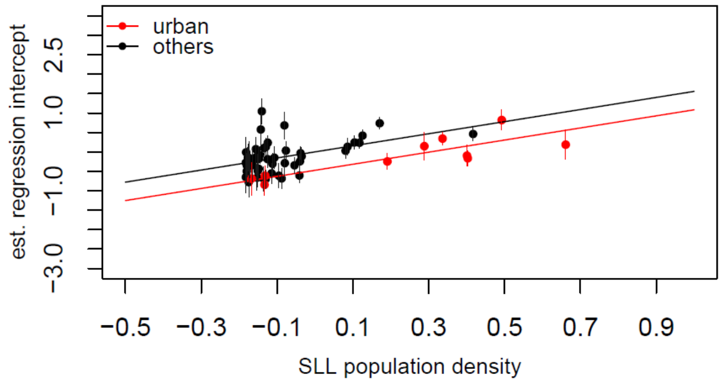
Fig. 2: Geographical distribution of SLL coefficient values



Source: Own elaboration

In figure 3 SLL coefficient for urban and non urban areas are compared. The lines represent the group level regressions for urban and non-urban SLL. The vertical bars are estimates of the standard deviation of SLL coefficients $\alpha_{j.}$ Results show that, for a given population density, being located in an urban SLL decrease the probability to exit. This counterintuitive outcome of the model may be explained either with the proximity with product market outlets or with the higher housing value of farms in these areas.

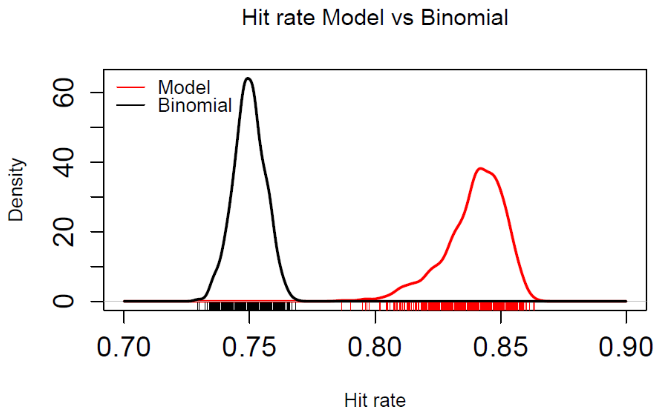
Figure 3: SLL coefficients vs SLL population density



Source: own elaboration

Finally we provide an overall measure of fit of the model calculating the percentage of correctly estimated farms who exit the industry compared with those obtained by drawing from an i.i.d. Bernoulli random variable with the θ parameter set to the sample farm exit rate (about 14%). The distribution of the hit rate for the probit model, obtained from the output of the Gibb sampler, does not overlap with the one obtained from the Bernoulli draws and it is displaced on the right as shown by figure 4. This suggests that the model has some non trivial in sample predictive capacity.

Figure 4: Distribution of model hit rate compared to random draw from a Bernoully distribution



Source: own elaboration

5. CONCLUSIONS

The paper provides a new analysis of the intertwining of farm and area level determinants of farm exit in a rural context diversified and spatially heterogeneous such as Tuscany. Differently from previous works which were based on separate farm and county models we approach the analysis within a single hierarchical or multilevel model where the exit probability is explained both at the farm level and at the territorial level respectively by individual and group regressors. Besides a set of internal features, which according with the previous literature impact on the exit rate (such as altitude, economic size, age of the farm operator and so on); the model considered also a set of characteristics at the territorial level (density of population and urban vs. rural nature of the surrounding area).

The model shows non trivial predictive capacity. The influence of farm characteristics is largely in accordance with previous literature: higher standard gross margin and livestock number seem to decrease the probability of exit. Conversely a higher age of the farm operator increases the probability of exit. Being members of producers association, living in the farm, and having household members younger than 45 years old working on farm negatively affect the exit behaviour. The only unexpected coefficient among farm-level predictors is that of altitude: indeed, according to data the location of the farm in a mountain area *decreases* the probability of exit. A finding which might be related to a lack of alternative opportunities in using the factors of production (land as well as labour) so that farmers are “locked in”.

The main novelty of the proposed approach is the introduction of both farm and territorial levels in the same model. Results show that, given the on-farm characteristics, the probability of a farm to survive during the considered period was decreased by the population density of the surrounding area and *increased* by the location of the farm within a sub-regional area classified as *urban*. The exit probability, net from farm level determinants, shows a quite clear geographical pattern, with the highest values in the north central and north-west area of the region, were the average size of farms was smaller and the population density higher at the beginning of the period considered by the study (2000-2007).

The introduction of the territorial level in the model specification seems to shed new light on the determinants of the observed structural change. The density of population can be considered as a proxy of competition of other production activities for the use of agricultural land: the higher the density, the stronger the pressure of alternative activities. The sign of the population density coefficient is positive as expected. But it should be considered together with the influence of the other "local" determinant. Given the population density, the location into a "urban" sub-regional area increases the probability to survive; an effect that may be interpreted as related to the presence of a larger set of market outlet for their product or to the higher housing value of farms in urban areas. Conversely, the positive effect of altitude on farm survival is more likely to express a lack of alternative opportunities in using the factors of production (land as well as labour).

The results show a structural dynamic polarised between rural areas where an increasing pressure of alternative uses of land pushes smaller farms to exit the sector notwithstanding the advantages of proximity to markets; and urban and mountain areas where opposite determinants slow down the exit dynamics. The balance between opposite influences is likely determining the final outcome of structural dynamics: that is, if the exit of farms from the sector supports a restructuring of remaining production units towards a larger, more efficient size; or, conversely, if also land leaves the sector together with farmers. The latter dynamic was likely to be in act in North West rural areas of Tuscany during the observed period.

The results provide useful information for the forthcoming design of the Rural Development policies for the next planning period (2014-2020). If determinants of structural change include also a relevant influence of the territory characteristics on the farms' exit, a well designed (evidence based) territorial diversification of incentives for farm investments should be considered as well as a stronger coordination between agricultural policies and land planning.

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