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HUMAN CAPITAL AND FARM HOUSEHOLDS: A MAP OF MANAGEMENT MODELS IN ITALY

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Abstract

This paper is designed to verify empirically the choices that Italian farm households make when investing in human capital. Census data from the National Institute of Statistics (Istat) were used to describe the main structural and organisational characteristics of the farms. Multivariate statistical tools were used to process the information in the database, so that the different types of Italian farm households could be defined and geographically located. The results allowed us to analyse the competence endowment inside the family farm by determining the existence, the types and the strength of the relationships between the characteristics of family farms and certain variables which described the specific local environment and the human capital available to the family. At the end of the paper we make some suggestions for norms which may be of value to policy makers.

Keywords: human capital, household farms, agricultural labour, spatial analysis.

Introduction

More than 90% of the 2.5 million Italian farm workers are exclusively or mainly family members (Istat, 2003). In such farm households the management models are conditioned by economic and extra-economic objectives and are influenced by various factors. Among these the most important are: i) the existence of employment opportunities other than labour on the farm (Mortensen, 1986); ii) subsidising underemployed labour resources (Barkley, 1990); iii) legislation on social security and welfare for agricultural workers and the rural population as well as access to effective incentives for early retirement (Sundstrom and David, 1988; Gale,1993); iv) the structure and size of the family holding and, to be more precise,

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the predominant property owning system in the area (Gasson and Errington, 1993); v) the availability of resources for investment in general and the specific knowledge of the availability of such resources in the family (Bernheim et al., 1985; Huffman, 2001). These environmental factors influence the farmers' organisational and strategic choices in different ways.

The adoption of organisational and management solutions by household farms has several implications for human capital investment and endowment. This argument is of great importance today, because the new European Agricultural Model (sustainable, multifunctional, competitive in the global arena) introduced by the recent CAP Reforms requires new skills and knowledge and the family farm has to immediately adapt to it (European Commission, 2003).

This paper is designed to verify empirically the choices that Italian farm households make when investing in human capital. A spatial analysis of the different types of firms was carried out, by drawing up a map of farm households in Italy. Census data from the National Institute of Statistics (Istat) were used to describe the main structural and organisational characteristics of the farms. Multivariate statistical tools were used to process the information in the database, so that the different types of Italian farm households could be defined and geographically located.

The diversity among farm types is related to the quality of the human resources available on the farms. There are some diagnostic parameters which can be used to describe this (educational levels, female involvement, young entrepreneurship etc.). The results allowed us to analyse the competence endowment inside the family farm by determining the existence, the types and the strength of the relationships between the characteristics of family farms and certain variables which described the specific local environment and the human capital available to the family.

Background

The human capital endowment of farms is an important factor which must be borne in mind when evaluating the relative competitiveness of local agricultural production systems. Among its components, the investments made in education and training over a period of time are frequently considered to be among the most significant factors when analysing farm efficiency as well as total factor productivity and real wages and income. There is a great quantity of economic theory literature and applied research essays and articles on the returns produced by such investments (see for example Schultz, 1964; Becker, 1993; Johnson, 2000). At the moment it is widely accepted that education and training investment is optimal when marginal returns are equal to marginal costs (Huffman, 2001). In other

words, such investments encourage qualified workers to take up off-farm employment, where the acquired knowledge and competence are rewarded by higher wages. This is true for farms where new technology is only adopted slowly. However when extra-farm wages are insensitive to qualifications and competence and agriculture can count on a constant stream of innovations which require new skills, then investment in education and training can ensure good returns inside the farms themselves. Empirical research has found that in developed countries additional schooling increases the likelihood that farmers will be employed in off-farm waged work. This is not necessarily the case for farmers working in the Green Revolution areas of developing countries[1] (Huffman, 2001). Investment in education and training is very sensitive to the time horizon of the choice. Thus, human capital investments made during the later stages of an individual's life are obviously of less value. By contrast, the steeper slope of the graph of the marginal costs of the investment suggests that human capital accumulation should be spread over more than one period (Huffman, 2001).

Census data shed some light on the conditions of Italian agriculture (Istat, 2003). Only about 64,000 people out of more than 2.4 million employed in agriculture have an agricultural science (or engineering) degree or diploma. This number rises to about 470,000 when all types of degrees and scholastic titles are included. A recent analysis found that farms managed by farmers with degrees in Agricultural Science had an average turnover of € 66,876, while the national average was only about € 15,000 (CNEL, 2004). The former work on farms with an average size of 19.9 hectares of farmland, corresponding to € 3,363 turnover per hectare, which is lower than the national level of € 3,409 per hectare. The specific characteristics of skilled farmers can be identified when one considers the turnover/days of labour ratio. In their farms this figure is estimated to be € 239 per day, far higher than the national average of € 124 (CNEL, 2004). These data are evidence of the technological gap between the different types of farms, where those managed by skilled farmers evidently adopt labour saving (such as mechanization) rather than land saving (such as fertilization) innovations. On the other hand, it is well known that capital investments substitute unskilled labour but increases the demand for skilled workers (Griliches, 1969).

1 The Green Revolution started in Mexico during the 1940s when the introduction of new disease resistance high-yield varieties of wheat, combined with modern mechanization technologies, made this country a net exporter of wheat in the 1960s. Except for Africa, countries all over the world benefited from the Green Revolution: USA, for example, became self-sufficient for wheat in the 1950s and a net exporter in the 1960s; thanks to a new variety of rice, IR8, India is today one of the world's leading rice producers (Briney, 2008)

A logistic regression model for high quality agricultural workers

Census data from the National Institute of Statistics (Istat) were used to describe the main structural and organisational characteristics of Italian farms in 2000. The data referred to NUTS3 territorial detail, i.e. to provincial administrations. A more detailed database, referring for example to local authorities (communes), was not available for all the variables which were considered relevant for this analysis. Table 1 show the variables used in the analysis.

Among other things, Table 1 highlights the high degree of variability of the low weight of qualified workers compared to total agricultural labour. A logistic regression was carried out to identify and evaluate the main factors explaining such variability. The logistic regression was estimated by the OLS method using the logistic transformation of the dependent variable y (GRA in Table 1),

Table 1 List of variables introduced in the logistic regression

Variables	Description	Mean	Standard dev.
GRA	Labour days of workers holding an agricultural sciences degree or diploma/Total labour days	0.046	0.031
PRO	Hectares of property/Total farm area	0.779	0.128
BIG	Total area of farms > 50 hectares/Total farm area	0.451	0.179
FAM	Total area of farms using family labour exclusively or predominantly/Total farm area	0.656	0.146
ARA	Hectares of arable crops/ agricultural area used	0.519	0.258
LIV	n. of livestock farms/n. farms	0.347	0.191
TRA	No. of farms owning tractors/No. of farms	0.441	0.225
YOU	Agricultural workers younger than 29/Total agricultural workers	0.137	0.030
MAL	Male agricultural workers/Total agricultural workers	0.649	0.102
AGR	Agricultural workers/Total workers	0.070	0.043

Source: data processed from Istat (2003)

$$\log\left(\frac{y}{1-y}\right) \tag{1}$$

and the fitted values from the regression were transformed as follows

$$y = \frac{1}{1 + e^{-\beta x}} \tag{2}$$

where x was the fitted value from the OLS regression and was the estimated coefficient. Data was processed using the Gretl™ v.1.8.1 econometric package.

Table 2 Logistic regression (dependent variable: GRA)

Variables	**Coefficient**	**St. Error**	**T ratio**	**P-value**
Constant	-3.420	0.834	-4.103	0.000***
PRO	-0.459	0.500	-0.918	0.361
BIG	-0.576	0.344	-1.671	0.098*
FAM	-0.932	0.471	-1.981	0.051*
ARA	0.401	0.186	2.156	0.034**
LIV	-1.004	0.278	-3.615	0.001***
TRA	2.108	0.266	7.912	0.000***
YOU	3.384	1.511	2.239	0.028**
MAL	0.422	0.429	0.986	0.327
AGR	-0.912	1.048	-0.870	0.387
RSS	11.164		St. err. regr.	0.346
R^2	0.675		R^2 corr.	0.643
F (9,63)	21.455		P-value (F)	0.000
Log-likelihood	-31.714			

Table 2 synthesizes the main results of the logistic regression[1]. The logistic regression brings up some interesting points. Looking at the structural characteristics, high quality human resources appear preferable in local agricultural systems where farms owning tractors are common, despite the low concentration of agricultural land in the hands of bigger farmers. A worker holding an agricultural sciences degree or diploma is more often found on arable rather than livestock farms. An important result is that qualified workers are more often employed on farms where the family are not the exclusive or predominant source of labour. This result does not necessarily imply that family farms do not invest in agricultural education, but simply indicates that skilled workers, whether they come from agricultural households or not, need to work in conjunction with external labour, giving birth - in

1 Here the full model is presented because the Maximum Likelihood Ratio test (producing a chi-squared value equal to 3.411 with 3 degrees of freedom corresponding to BIG, MAL and AGR variables excluded because of their low significant coefficients) showed the limited gain of significance coming from the reduced model. Akaike, Schwarz and Hannan-Quinn criteria support this choice.

both cases - to “capitalist” farms, as they were labelled in the past. With reference to the social factors, the relationship between high quality human capital and the large number of young workers in the total number of local agricultural workers is noteworthy. This result highlights the importance of inter-generational transfer in rural households in improving the qualifications of the human resources in agriculture.

Synthesizing the logistic regression results, today agricultural education investment in Italy is best exploited in regions where farmers preferably employ external labour, use their own tractors and produce arable crops rather than dairy goods or meat. The high percentage of young workers in agricultural employment indicates that agriculture offers concrete prospects of income and employment in these areas. In such areas the low concentration of landholding is principally an indicator of the difficulties faced by young qualified farmers when trying to set up farms on their own land. These elements seem to be the most important ones which policy makers should concentrate on when drawing up labour qualification policies for agriculture.

A Discriminant Analysis of farm households

Deeper analysis of the characteristics of farm households in Italy shows that there are links between the geographical location of the agricultural activities and the role of qualified workers in the farm management. A Linear Discriminant Analysis was made in order to define the different types of farm households and their location in Italy.

The 103 provinces were classified with reference to two parameters. First, the FAM variable described in Table 1: the provinces where the FAM was larger than the national mean were separated from those where the FAM was smaller. In this way an objective, although relative, classification of local agricultural activities was made which took into consideration the importance and the spatial diffusion of household farms. Second, the provinces located in the Northern and Central Regions of Italy were separated from the “Mezzogiorno” (Southern Italy and the islands of Sicily and Sardinia) provinces. This double classification gave us 4 different groups of provincial farms.

Table 3 Classification groups for Linear Discriminant Analysis

		Type of farm	
		FAM>national mean	FAM<national mean
Area	North-Centre	1	2
	South-Islands	3	4

Table 4 List of variables for Linear Discriminant Analysis

Variables	Description	Mean	Standard dev.
PLO	No. of plots/No. of farms	5.053	4.558
REN	Hectares rented/Total farm area	0.176	0.125
PRO	Hectares of property/Total farm area	0.779	0.128
SIZ	Total farm area/No. of farms	11.123	9.070
UAA	Agricultural Area used/Total farm area	0.682	0.167
ARA	Hectares of arable crops/Agricultural Area used	0.519	0.258
PER	Hectares of permanent crops/Agricultural Area used	0.200	0.167
LIV	No. of livestock farms/No. of farms	0.347	0.191
MAC	No. of farms using machines/No of farms	0.871	0.072
TRA	No. of farms owning tractors/No. of farms	0.441	0.225
YOU	Agricultural workers younger than 29 years of age/Total agricultural workers	0.137	0.030
OLD	Agricultural workers older than 55 years of age/Total agricultural workers	0.226	0.050
MAL	Male agricultural workers/Total agricultural workers	0.649	0.102
AGR	Agricultural workers/Total workers	0.070	0.043
DIP	Days of labour days of workers holding a degree or diploma/Total days of labour	0.192	0.065

Source: data processed from Istat (2003)

The classification was created using some quality parameters for human resources on farms as well as some variables which described the main structural conditions of local agriculture. For the educational training indicators the focus was on total number of workers holding some kind of Bachelor's or university degree or diploma rather than on individuals who had completed special agricultural sciences courses, because this latter parameter did not have significant discriminatory power. Data was processed using the SPSS^{TM} v. 12.0 statistical packages.

The basic assumptions made on multivariate normal distribution, homogeneity of variances/covariance across groups and correlations between means and variances were successfully tested[1]. Three canonical discriminant functions were used for the classification.

1 With specific reference to the homogeneity of variances/covariance, Box's M test was 892.858, corresponding to a F (240, 14171.189) approximately equal to 2.720.

Table 5 Canonical Discriminant Functions

Eigenvalues				
Function	Eigenvalue	% variance	% accumulated	Canonical Correlation
1	3.607	74.6	74.6	0.885
2	0.963	19.9	94.6	0.700
3	0.262	5.4	100.0	0.455
	Wilks' Lambda			
Test of Functions	Wilks' Lambda	Chi-squared	df	Sig.
1 to 3	0.088	225.192	45	0.000
2 to 3	0.404	83.897	28	0.000
3	0.793	21.494	13	0.064

The following tables allow us to synthesize the main results of the Discriminant Analysis. The Structural Matrix shows the correlations within the groups between discriminant variables and standardized canonical discriminant functions. The significance of the coefficients is made clear, on one hand, by the group means for each function, and on the other, by the territorial map.

The classification of Italian farms based on their geographical location was found to be a good choice. Discriminant function 1 separated Northern and Central Italy from the Mezzogiorno. Local agricultural systems with predominantly family labour forces were clearly identified along the vertical dimension of discriminant function 2. Structural parameters rather than human quality resource variables characterised such types of farms. To be more precise, the high incidence of UAA as a proportion of total farm area, of arable crops as a proportion of UAA, the mechanization of agricultural operations and the widespread use of farmland were the most powerful discriminant variables for characterising family farms in Italy. Human quality resources were mainly discriminant factors between the North and the South. Thus, older workers were more common in North and Central Italy, where diploma or degree holders find better conditions for employment in agriculture. This result has to be compared with the large number of workers employed in agriculture in the Southern provinces.

The canonical discriminant functions were used to predict the groups for each provincial agricultural system. The prediction was based on the Mahalanobis distance from group centroid and took into account the a priori probabilities of the farms belonging to one of the 4 groups.

Table 6 Structural Matrix

	Function		
	1	**2**	**3**
TRA	0.522*	-0.469	0.064
AGR	-0.444*	-0.106	0.189
LIV	0.371*	-0.029	0.086
OLD	0.343*	-0.326	-0.028
PER	-0.297*	0.148	0.252
SIZ	0.205*	0.131	-0.066
DIP	0.194*	0.007	0.176
PLO	0.134*	0.092	0.056
UAA	-0.177	-0.725*	0.133
ARA	0.099	-0.518*	-0.121
MAC	0.006	-0.464*	0.120
REN	0.306	-0.448*	0.308
PRO	-0.271	0.397*	-0.231
MAL	0.069	-0.253	-0.552*
YOU	0.031	0.189	-0.202*

Table 7 Group means for the discriminant functions

Group	**Function**		
	1	**2**	**3**
1	1.485	-0.935	0.266
2	1.219	1.183	-0.310
3	-2.464	-0.682	-0.599
4	-2.646	0.856	0.944

Discriminant analysis confirmed the first impressions suggested by the logistic regression: human capital investments in education need the support of positive present conditions and future prospects for agricultural activity. While logistic regression highlighted the importance of the good structural state of the farms, discriminant analysis showed that such conditions are more often found in North and Central Italy.

Figure 1 Territorial Map

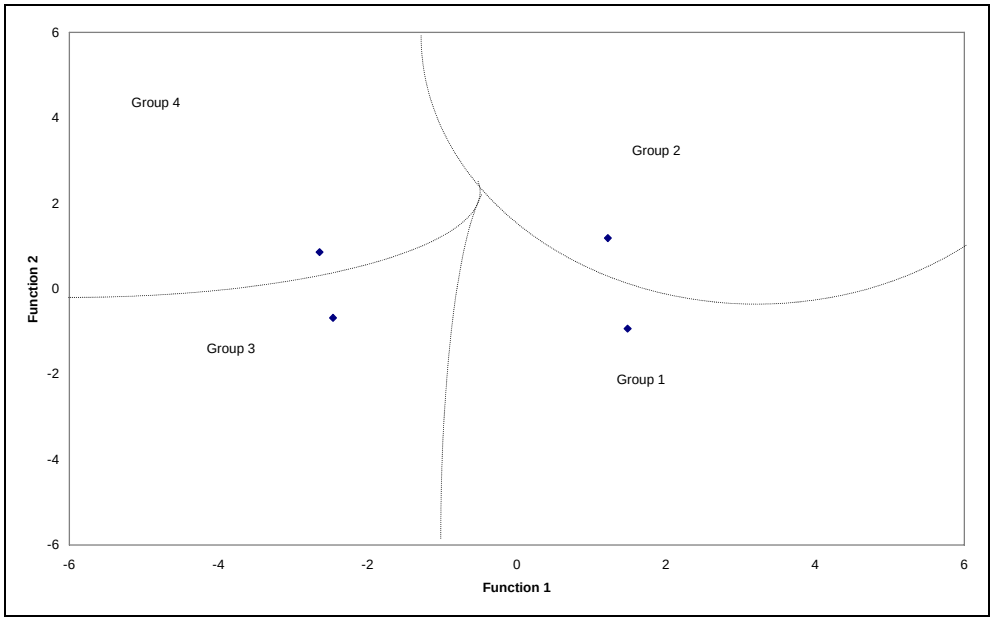

Table 8 – Classification results

Original	Predicted				Total
	1	**2**	**3**	**4**	
1	32	3	1	0	36
2	4	26	0	1	31
3	1	0	19	2	22
4	0	1	3	10	14
Total	37	30	23	13	103

84.5% cases correctly classified

Some concluding remarks

A map of human resource endowment in Italian farm households was created. Among other things, the most important results confirmed the arguments of the literature on economic theory and also the results of past empirical studies. The results confirmed that there are “two Italy's”, mainly differentiated by factor endowments and socio-economic environmental conditions. In North and Central Italy agriculture sometimes offers better economic conditions and prospects for a new generation of skilled farmers. Agricultural science diploma or degree holders

have more possibility of finding work in areas where there is significant investment in mechanisation, where arable crops are cultivated and where there are a significant number of extra-family workers in the agricultural work force. This suggests that policy makers have to bear in mind that training and qualifying the human resources employed in agriculture is not a problem of institutional education or training. What is needed is a holistic development plan with structural as well as social and institutional objectives. The specific local economic, social and institutional conditions should be given greater weight in such plans.

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