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# THE DETERMINANTS OF INNOVATION IN THE ITALIAN FOOD INDUSTRY: THE ROLE OF R&D NETWORKING\*

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della Commissione Europea

Paper prepared for the 109th EAAE Seminar " THE CAP AFTER THE FISCHLER REFORM: NATIONAL IMPLEMENTATIONS, IMPACT ASSESSMENT AND THE AGENDA FOR FUTURE REFORMS".

Viterbo, Italy, November 20-21st, 2008.

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\* This work has been implemented under the research project: "Spillovers sistemici sulla competitività dell'industria italiana: una valutazione quantitativa per le politiche di settore", PRIN 2004. We thank Attilio Luigi Pasetto, of Capitalia, for kindly providing us the data, and Francesco de Stefano, Roberto Esposti, Pasquale Lombardi, Gianluca Nardone, Maria Laura Parisi and Ermanno Tortia for their helpful suggestions on a previous version of this paper. The usual disclaimer applies.

## **Abstract**

Objective of the paper is to verify which are the determinants of innovations in the Italian food industry and which role R&D networking, through the cooperative nature of firm, plays among these determinants.

The data used are the 9<sup>th</sup> (2001-2003) wave of Capitalia surveys based on a representative sample of manufacturing firms with information on firm characteristics, employee education levels, innovation and R&D investments.

The approach is a bivariate probit analysis where the two dependent variables are the presence of firm R&D and of innovations and the independent variables are firm characteristics.

The results of the analysis show that, among the determinants of firm R&D *intra moenia* and of firm innovations in the Italian food industry for the years 2001-03, the presence of subsidies for R&D *extra moenia*, is the most significant variable with the highest marginal effect while the cooperative variable turns out to be positive and significant (6%) after including relative input prices.

**Keywords:** innovations, R&D networking, firm property rights.

**JEL:** O31, O32, D21

## Introduction

In the literature, the persistence of cooperatives in competitive markets has rarely been linked to innovation and networking capabilities, such as Novkovic (2007) who proposes an evolutionary model in a mixed industry where the innovation strategy of a cooperative is oriented toward the adoption of labour-intensive technology. The resulting survival strategy for the cooperative is the creation of cooperative networking. Becchetti *et al.* (2005) suggest a theoretical model of horizontally differentiated duopoly where competition is based on price and on social responsibility between a non profit firm and a for profit firm. Here, the innovation can be considered the adoption of a socially responsible behaviour. If the interest of consumers in social responsibility overcomes a certain threshold, the for profit producer also adopts a strategy of social responsibility; the imitation is higher in a dynamic context because of the persistence and self-strengthening with time of socially responsible consumers' habits.

The impact of ownership on economic performance has been the subject of considerable theoretical debate (started by Alchian and Demsetz, 1972) and of empirical investigation. For example, a tightening in financial constraints (Maietta and Sena, 2004) and an increasing product market competition (Maietta *et al.* 2008; Maietta and Sena, 2008a) tend to increase the efficiency of producer cooperatives and then to be beneficial to the survival of this kind of firms; at the same time, no evidence of cooperative undercapitalisation has been verified for the Italian food industry (Coppola *et al.*, 2008; Maietta and Sena, 2008b).

The importance of firm networking for innovation has been recognized in the Rural Development Plans (period 2007-2013) by offering a new opportunity to finance R&D collaboration: the measure 124 aimed at introducing innovations both in farms and in food industry firms. However, the discussion with regional socio-economic partners has not always revealed big enthusiasm for this new measure: for example in Basilicata, the agricultural associations have asked to eliminate this measure from the regional plan.

The aim of this paper is to assess the role of R&D networking, through the cooperative nature of firm, on the introduction of innovations in the Italian food industry with respect to other determinants, customarily used in literature, to explain the introduction of innovations, such as skilled employees and R&D *intra* and *extra moenia* (Piga and Vivarelli, 2004; Medda *et al.*; 2005; Parisi *et al.* 2006; De Jong and Vermeulen, 2007). The analysis is performed by using the information on the Italian food industry firms contained in the 9<sup>th</sup> (2001-2003) wave of the Capitalia survey.

## Methodology

### *The bivariate probit regression*

We adopt a bivariate probit regression (Greene, 2004) where the dependent variables refer to the presence of firm R&D *intra moenia* and of firm innovations while the covariates are variables which influenced the probabilities of observing both the events. More precisely,  $y_1^*$  and  $y_2^*$  are latent variables, such that:

$$y_1^* = \text{presence of firm R\&D } \textit{intra moenia};$$

$$y_2^* = \text{presence of firm innovation};$$

$\mathbf{x}$  = vector of firm structure variables which influences the probability of firm R&D *intra moenia*;

$\mathbf{z}$  = variable vector which influenced the probability of firm innovations;

$$y_1^* = \boldsymbol{\beta}'\mathbf{x} + u, \quad F_{\text{R\&D}} = 1, \text{ if } y_1^* > 0, \quad 0 \text{ otherwise,}$$

$$y_2^* = \boldsymbol{\delta}'\mathbf{z} + v, \quad F_{\text{INN}} = 1, \text{ if } y_2^* > 0, \quad 0 \text{ otherwise,}$$

$$E(u \mid \mathbf{x}, \mathbf{z}) = E(v \mid \mathbf{x}, \mathbf{z}) = 0,$$

$$\text{Var}(u \mid \mathbf{x}, \mathbf{z}) = \text{Var}(v \mid \mathbf{x}, \mathbf{z}) = 1,$$

$$\text{Cov}(u, v \mid \mathbf{x}, \mathbf{z}) = \rho$$

### *The data*

The source of the data used in this paper is the manufacturing firm survey, conducted by (former Mediocredito Centrale) Capitalia, for the periods 2001-2003 (9<sup>th</sup>). The Survey collects information on a representative sample of manufacturing firms operating in Italy with more than ten employees and all firms with more than 500 employees. Using ATECO classification, we extracted a sample of 484 firms for the food industry in the period under examination. Capitalia Surveys collect information on the introduction of innovations and on firm characteristics, such as the collaboration with universities, public and private research labs. Table 1 reports the descriptive statistics for the sample examined.

**Table 1 - Descriptive statistics for the food industry firms in the sample**

Variable	Italy	South
N. firms	484	154
Firms with product innovations	275	96
Firms with process innovations	166	50
Firms with other innovations	100	33
Turnover average (ml €)	31622	19589
Investment rating (th €)	963	747

R&D/turnover (%)	0.24	0.21
No. employees (average)	87	56
Skilled employees (%)	1.6	1.8
Firms with intra moenia R&D	126	36
Firms with R&D from universities and public research labs	35	35
Firm with R&D from other firms	44	44
Firms with non standard jobs (%)	67	58
Firms that receive subsidies	245	95
Cooperatives	81	27

### ***The empirical specification***

The specification adopted for the index functions of the bivariate probit regression are the following:

$$F_{R\&D} = \beta_0 + \beta_1 \text{ Skilled employees} + \beta_2 \text{ Non standard jobs} + \beta_3 \text{ Subsidies for extra moenia R\&D} + \beta_4 \text{ Cooperative} + \text{firm relative prices} + \text{North and South dummies}$$

$$F_{INN} = \delta_0 + \delta_1 \text{ Imm} + \delta_2 \text{ District} + \delta_3 \text{ Province social capital} + \delta_4 \text{ R\&D extra-moenia} + \delta_5 \text{ Cooperative} + \delta_6 \text{ Product quality improvement} + \delta_7 \text{ Environment friendly technology} + \text{North and South dummies} + \text{dummies for size classes and subsectors}$$

where:

Non standard jobs, Subsidies for *extra moenia* R&D, Cooperative, R&D *extra-moenia*, Product quality improvement, Environment friendly technology are dummy variables;

Skilled employees = share of graduate employees;

Firm relative price proxies, calculated from the firm balance sheets, are averaged over the three years:

user cost of capital

Materials/turnover

Imm = immaterial capital on total capital

Size classes dummies are defined according to AGRA classification (2004):

Size class 3 = 5 - 25 ml € turnover

Size class 4 = 25 - 50 ml € turnover

Size class 5 =  $\geq$  50 ml € turnover

Province social capital is sourced from Sessa (1998) and is referred to the province where the firm is located.

### ***Econometric results***

This section illustrates the results from the econometric analysis on firm innovative behaviour. Our sample reduces respectively to 345 observations, due to missing values.

Tables 2 and 3 contain the estimates of the coefficients (with their  $p$ -values) of the two univariate probit regressions. In general, the regression fit is good as the covariates used are significant as it is possible to judge from the value of the Wald test performed on the joint significance of all the [Wald  $\chi^2$  (30) = 90.42, Prob >  $\chi^2$  = 0.0000]. Besides, the value of  $\rho$  is high (0.62998) and significant [LR test of  $\rho=0$ :  $\chi^2$  (1) = 12.357, Prob  $\chi^2$  = 0.0004].

Table 2 - *R&D intra moenia determinants*

<b>Variable</b>	<b>Coef.</b>	<b>z</b>	<b>p-value</b>
Skilled employees	0.12	<b>3.41</b>	0.001
Non standard jobs	0.58	<b>3.24</b>	0.001
Subsidies for <i>extra moenia</i> R&D	2.79	<b>3.42</b>	0.001
User cost of capital	-0.24	-2.52	0.012
Immaterial capital on total	0.44	1.26	0.208
Materials/turnover	-1.77	<b>-3.13</b>	0.002
User cost of capital*Coop	0.18	0.93	0.351
Immaterial capital on total*Coop	-0.48	-0.58	0.565
Materials/turnover* Coop	-2.63	-1.06	0.29
Coop	2.46	1.15	0.248
North	0.29	1.04	0.297
South	-0.04	-0.13	0.896
Constant	-0.20	-0.39	0.699

Table 3 - *Innovation determinants*

<b>Variable</b>	<b>Coef.</b>	<b>z</b>	<b>P&gt; z </b>
Immaterial capital on total	-0.65	<b>-1.86</b>	0.063
R&D extra moenia	0.67	<b>1.63</b>	0.104
District	0.07	0.33	0.739
Social capital	0.01	1.50	0.133
Coop	-0.12	-0.46	0.644
Product quality improment	0.11	1.27	0.205
Envir. friendly technology	0.31	<b>2.62</b>	0.009
Size class 5 - 25 ml € turnover	0.35	1.52	0.128
Size class 25 - 50 ml € turnover	0.50	1.41	0.159
Size class ≥ 50 ml € turnover	0.25	0.76	0.449
North	-0.09	-0.29	0.775
South	0.23	0.68	0.499
Meat dummy	-0.99	<b>-3.28</b>	0.001
Fruit&vegetable dummy	-1.15	<b>-3.64</b>	0.000
Dairy dummy	-0.83	<b>-2.70</b>	0.007
Rice dummy	-1.32	<b>-3.36</b>	0.001
Constant	0.53	1.03	0.304

Table 4 contains the estimates of the marginal effects (with their p-values) for the bivariate probit model regression related to the 2001-2003 period.

From table 4, subsidies for R&D *extra moenia* have the highest impact on firm R&D and innovation; this result is confirmed by the evidence that public subsidies for university-industry collaborations have been important and particularly used in the food industry compared to other sectors in Southern Italy (Istituto Guglielmo Tagliacarne, 2004). Non standard jobs and skilled employees are also significant variables. Among the proxies of relative prices, the variable materials on turnover has a negative impact on firm R&D and innovations; after including the relative prices, the coop dummy is positive and significant (6%).

We do not observe a statistically significant difference between firms belonging to different size classes, geographic areas and sub-sectors as all size, geographical, territorial and sub-sector dummies are not significant.



Table 4 - *Marginal effects of R&D intra moenia and innovation determinants*

<b>Variable</b>	<b>dy/dx</b>	<b>z</b>	<b>P&gt; z </b>
Skilled employees	<b>0.04</b>	<b>3.42</b>	0.001
Non standard jobs	<b>0.17</b>	<b>3.42</b>	0.001
Subsidies for extra moenia R&D	<b>0.67</b>	<b>17.01</b>	0.000
User cost of capital	-0.08	-2.49	0.013
Immaterial capital on total	0.13	1.22	0.224
Materials/turnover	<b>-0.56</b>	<b>-3.14</b>	0.002
User cost of capital *Coop	0.06	0.92	0.357
Immaterial capital on total *Coop	-0.15	-0.58	0.565
Materials/turnover * Coop	-0.83	-1.06	0.290
Coop	<b>0.68</b>	<b>2.77</b>	0.006
North	0.09	1.04	0.299
South	-0.01	-0.12	0.908
R&D <i>extra moenia</i>	0.00	0.74	0.462
District	0.00	0.32	0.748
Social capital	0.00	0.71	0.475
Product quality improvment	0.00	0.68	0.498
Envir. friendly technology	0.00	0.84	0.402
Size class and sector dummies	not significant		

Log likelihood = -284.026

### Concluding remarks

The aim of this work is to assess the determinants of the introduction of innovations in the Italian food industry and whether they differ according to firm property rights. The analysis was carried out by applying a bivariate probit regression model to the data of food firms sourced from the 9<sup>th</sup> (2001-2003) wave of the Capitalia Survey.

The results of the analysis show that the determinants of firm R&D *intra moenia* and innovations in the food industry have been: the subsidies for R&D *extra moenia*, which have the highest marginal effect, while the cooperative dummy, after including input relative prices and their interactions with the former, turns out to be positive and significant (6%). Non standard jobs and skilled employees also show a positive impact while the variable materials on turnover has a negative impact on firm R&D and innovations.

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