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Do durum wheat producers benefit of vertical coordination?

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Abstract

This study aims at assessing if benefits, based on the economic performance of farms operating in an agro-food supply chain, are generated by a vertical coordination. A panel data (2008–2011) of durum wheat producers was used, namely the Italian Farm Accountancy Data Network (FADN). Outcomes of coordinated and non-coordinated farms with equal farm and farmer characteristics were calculated through different economic performance measures. A propensity score-matching model was implemented to take account of the selection bias due to observed individual heterogeneity. The comparisons of average differences in farm economic performance indexes, including costs and profitability, show a coordination premium in competitiveness and profitability of Italian durum wheat farms.

Keywords: Vertical coordination, Farm economic efficiency, Propensity score matching, FADN

Background

According to several observers, vertically coordinated supply chain relationships of agri-food markets prevail nowadays as dominant strategies (Vetter and Karantininis 2002; Ménard 2004; Mènard and Valceschini 2005; MacDonald and Korb 2008; Jang and Olson 2010; Cembalo et al. 2014a). Quality, healthiness, and nutritional values of meals are some of the determinants of food demand (Jang and Olson 2010). Thereby, several scholars support the idea that both processors and retailers need detailed information about the use of raw materials and the compliance to specific production norms, to certify the quality of their products (Reardon et al. 2003; Mac Donald et al. 2004; Mènard 2004; Bertazzoli et al. 2011). Since smooth and transparent supply chain relationships are one of the pre-condition for market competitiveness and farms profitability (Jang and Olson 2010; Jarzebowski et al. 2013; Morales et al. 2013), contract farming represents an effective tool to trace and promote high-quality productions in food sector (Cembalo et al. 2014b; Carillo 2016).

Contract farming is considered decisive to foster primary production, where small farms operating in oligopsony environmental markets are the prevalent setting Drescher and Maurer 1999; Kularatna et al. 2001; Bogetoft and Olsen 2002; Kirstem and Sartorius 2002; Barret et al. 2012; Bellemare 2012). Benefits for smallholders are generally associated with the mitigation of market risks and the prevention of market failures, such as access to credit, new markets, innovative technologies, and technical

services (Grosh 1994; Key and Runsten 1999). Based on these reasons, the diffusion of such contracts is often considered a good strategy for value creation in rural economies.

Italian dry pasta sector reveals an increment in the use of contract farming (Zanni and Viaggi 2012; Solazzo et al. 2015; Carillo 2016). This sector shows a polarized structure: a few large international companies that hold the majority of market share, and a plurality of small and artisanal firms that operate in specific market niches. Since dry pasta market is saturated and has few opportunities for innovation, product differentiation takes place through the adoption of particular varieties of grains (e.g., traditional, local) and/or specific schemes of certified quality (e.g., organic). For instance, some Italian firms have launched pasta produced by using 100% Italian grains semolina, often by recovering traditional local varieties. By contract farming, firms guarantee the use of raw materials that are qualitatively and quantitatively appropriate to their productive standards.

A reasonable number of studies have been devoted in Italy to this topic (Bertazzoli et al. 2011; Zanni and Viaggi 2012; Solazzo et al. 2015; Carillo 2016), but none of these, to the best of our knowledge, focused on the economic benefits for farms. The current paper aims to fill this gap by verifying whether farms vertically coordinated, when compared with non-coordinated ones, gain benefits in terms of higher selling price, cost reduction or overall profitability. A propensity score matching (PSM) model was implemented to estimate the average effect of vertical coordination using a representative sample of Italian durum wheat producers. PSM method allows reducing the estimations bias resulting from directly comparing two groups, namely vertically and non-vertically integrated. To illustrate, if we had ignored farm characteristics related to the outcomes, we would have not been able to assign the differences found in economic performance indexes only to the effect of vertical coordination. To search for unbiased estimations, several robustness tests were undertaken to ensure that the identification strategy selected was not compromised by other factors, such as heterogeneity deriving from unobserved farm characteristics.

Main results provide evidence that a coordination premium for vertically coordinated farms arises. This premium transits through differences in gross sales, gross margin and overall profitability, while costs and yields of production remain unchanged. Based on these findings, it is possible to assess that coordinated farms benefit of high market prices and, then, vertical coordination improves their bargaining power.

The remaining of the paper is organized as follows: In the "Vertical coordination in the food sector—literature review" section empirical literature on vertical coordination in agri-food sector is described, while methodology and data employed are discussed in the "Methods" section. The "Results" section presents results of the propensity scores matching model. The "Discussion and conclusions" section is dedicated to discussions and some concluding remarks.

Vertical coordination in the food sector—literature review

During recent years, commercial transactions in the agri-food sector are growingly regulated through contracts that coordinate different stages of the supply chain (MacDonald and Korb 2008; Jang and Olson 2010; Chen and Yu 2013). To illustrate, some works demonstrate that in 2005, 41% of US agricultural production value was sold by

contract farming (MacDonald and Korb 2008; Jang and Olson 2010). Sales subscribed by contract farming amounted for 28% over the total production value in 1991, whereas in 1969, the same ratio was only 11% (Mac-Donald and Korb 2008). More specifically, some US sectors used to get provisions from the spot markets (e.g., wheat, oilseeds, pork meat, and tobacco) noticeably increased the use of contracts in the period 1991–2005. In the cases of wheat and pork meat, the percentages of total production value sold through vertical coordination contracts increased noticeably from 5.9 to 7.5% and from 11 to 65.6% (Jang and Olson 2010).

European countries report similar increments, mainly in the field of vegetables and livestock products. In Germany, the percentages of chicken meat traded by contracts over total sales, in the decade 1991–2002, increased from 3.6 to 5.1%. In Italy, this share passed from 0.1 to 9.3%; in Spain, it went from 13.1 to 25.4%; in France from 6.7 to 17.7; in the Netherlands from 5.2 to 9.4%; and in the UK from 11.2 to 30.6% (Jang and Olson 2010).

This phenomenon is due to diverse factors that are both exogenous (climate change, global economic crisis, EU balance) and endogenous (e.g., evolution of food demand, growing oligopolistic concentration of food distribution) to specific markets (e.g., Bertazzoli et al. 2011). Specifically, modern food demand is highly conditioned by the quality and the nutritional value of products (e.g., Jang and Olson 2010). Consequently, food-processing companies need detailed information concerning key elements of their raw materials, aiming at guaranteeing the quality of products and the certification of production processes (Reardon et al. 2003; Mac Donald et al. 2004; Mènard 2004). Therefore, smooth and transparent supply chain relationships are considered as preconditions for market competitiveness and profitability (Jang and Olson 2010; Jarzebowski et al. 2013) and coordination contracts represent effective tools to trace and promote high-quality productions (Bertazzoli et al. 2011; Morales et al. 2013).

From a theoretical point of view, the institutionalist approach explains the choice of autonomous companies to adopt coordination mechanism, starting from imperfections in the transmission of information. In the presence of opportunistic behaviors and limited rationality of the agents, the mechanisms that regulate information transmission are characterized by making incomplete spot contracts (Akerlof 1970; Stiglitz 1987; Hart and Moore 1990; Williamson 1996; Mènard 2004). According to this approach, the more these factors are relevant, the more transaction costs increase (usage costs of the market) and the company is incentivized to seek stable forms of coordination, up to the full coordination one (hierarchical/proprietary integration).

In particular, as for the issue of quality, buyers and retailers often have different criteria to evaluate the quality of a good exchanged in the market; unless a social interaction takes place bringing to a shared agreement (Stiglitz 1987). Then, contracts represent a peculiar modality of market transaction suited for goods whose quality features are not easily detectable. This modality allows buyers to transmit buyer—specific product attributes information and to get secondary information from producers, concerning production methods, inputs of production, etc.

In the case of relationships between agriculture and food industry and/or big retail channels, contract farming represents the legal form commonly used to realize the coordination. This kind of contract normally defines in some detail both production techniques and inputs that farmers have to comply to.

Many empirical works have analyzed contract farming, but they are almost exclusively focused on less-developed countries. The literature can be divided into two major strands: Some authors have preferred the study of the decisional process that leads to subscribe the agreements, highlighting which characteristics, attitudes, and motivations are able to promote stable relationships among stakeholders (Drescher and Maurer 1999; Kularatna et al. 2001; Bogetoft and Olsen 2002; Kirstem and Sartorius 2002; Vetter and Karantinimis 2002; Key and McBride 2003; Sykuta and Parcell 2003; Key 2004; Mènard and Valceschini 2005; Key and MacDonald 2006; Boessen et al. 2010). Other scholars focused their studies on analysis of the effects, deriving from cooperation, on the efficiency, profitability, and competitiveness of the supply chain (Wang and Jaenicke 2006; Hendrikse 2007; Miyata et al. 2009; Jarzebowski et al. 2013).

From a regional point of view, as already said, most of these works addressed the pros and cons of vertical coordination mainly in rural areas of developing countries, and more precisely, they analyzed whether vertical coordination might improve the livelihood conditions of small holder farmers and if it would be useful to trigger a virtuous development in the rural areas of these countries. To illustrate, a meta-narrative approach was used by Barret et al. (2012) to make a comparative analysis of case studies carried out in five low-income countries (Ghana, India, Madagascar, Mozambique, and Nicaragua). Authors found that the well-being of farmers is generally increased by the participation to contract farming. Miyata et al. (2009), analyzing apple and onion farmers of a province in China, found that those applying contract farming showed higher income. A contingent-evaluation experiment carried out on various farm types and crops in six regions of Madagascar demonstrated that the increase of 1% in the probability to participate to contract farming has a direct effect on farmers' income of more than 0.5% (Bellemare 2012). Narayanan (2014) carried out an impact evaluation of vertical coordination in some supply chain in southern India. Results showed that participation profits were heterogeneous, depending on (*i*) the sector (higher for papaya and chicken meat), on (*ii*) contract scheme, and on (*iii*) farm type. Narayanan (2014) also performs a profit (coming from coordination) decomposition (loss) exercise: incomes realized by coordinated farmers are high enough to compensate higher costs due to the cultivation contracts. Chang et al. (2006) evaluated a program launched in Taiwan in 2005 to support the subscription to marketing contracts in the rice sector. Authors highlight that farms involved show, on average, greater returns (11%), lower production costs (13%) and that the combination of these dimensions results in a plus in the gross product margins (about 50%). Finally, other Indian studies, concerning the same topic (Tripathi et al. 2005; Singh 2007; Gulati et al. 2008), demonstrate both higher costs and returns associated to cultivation contracts, with the latter caused by increased yields, higher prices, as well as by reduction of transaction costs (for specialized warehouses, transportation, marketing).

In European countries, few studies were conducted on this topic. Jarzebowski et al. (2013) analyze the cereals industry in Poland: Authors show that a higher vertical integration (whether downstream or upstream) of the food firms has a positive effect on their efficiency. Despite the strong interest shown by Italian scholars on this issue, there are not empirical studies carried out in Italy assessing if and at what extent there are real economic advantages for farms in participating to such contracts. This is probably due to the lack of statistical data and reliable information, as well as some

methodological challenges, related to estimation of the causal impact. Indeed, contract farming are not subscribed randomly by farms but may depend on a set of both noticeable and latent producers and farms characteristics (competence of the entrepreneurs, risk aversion, technical skills, networks embeddedness, etc.) (Barret et al. 2012; Carillo 2016). Our contribution faces explicitly all these issues, analyzing empirically the role of vertical coordination in improving the economic performances of Italian farms.

Methods

The adopted empirical approach aims to estimate the coordination premium for farms due to being vertically coordinated. The coordination premium is calculated as differences in farms competitiveness and profitability, comparing vertically and non-vertically coordinated farms. The first step involves the identification and the definition of the competitiveness and profitability measures throughout the data provided by the FADN. The measures strictly need to be functional with the scope of the investigation: Gross sales, net income, variable costs, and fixed costs per hectares of UAA (utilised agricultural area) were computed per each of the 2450 durum wheat producers included in the Italian FADN in the years from 2008 to 2011. Moreover, the relative profit difference (RPD) was calculated as an efficiency standardized measure of profitability of farms (Boone 2008). More in detail, ordering farms according to their economic efficiency (decreasing in i, with i being the i-th farm in the sample), RPD_i can be computed as:

$$\mathrm{RPD}_i = \frac{\pi_i - \pi_N}{\pi_1 - \pi_N} \tag{1}$$

Where is π_1 is the profit corresponding to the farm with the highest level of efficiency, while π_N corresponds to the profit of the least efficient farm. As a measure of efficiency, we use the $variable\ costs_i/gross\ sales_i$ ratio, with $gross\ sales_i$ corresponding to the whole sale coming from all agricultural products sold by the i-th farm. Moreover, several performance measures were computed on durum wheat production: durum wheat gross sale, gross margin (gross sales minus direct production costs), yield per hectare, and variable costs.

The second step relates to the implementation of the propensity score matching (PSM). In quasi-experimental studies, or in non-randomized settings, it is essential to identify the treatment effects considering the different pre-treatment conditions between treated and untreated (Rosenbaum 2002). It is worth noting that treated and control are terms of experimental studies. We decided to keep this terminology accordingly even though there is not a specific treatment to be analyzed. However, for treated, we intend vertically integrated/coordinated farms and for untreated, or control group, those farms not vertically coordinated. The so-called propensity score aims to reduce the multidimensional information that affects the pre-condition differences between treated and untreated to only one score. When the status of being vertically coordinated ($\mathrm{VC_i} = 1$) is not randomly assigned but stochastically depends on a set of observable characteristics, the propensity score can be implemented as a measure of conditional probability of being vertically coordinated conditional upon the observed variables, x, that include farm and farmer characteristics (reported in Table 1).

Table 1 Descriptive statistics of variables for coordinated and non-coordinated farms

Variables	All sample		Vertically coordinated farms	Non-coordinated farms
	(obs. 2450)		(obs. 183)	(obs. 2267)
	Mean	Std.dev	Mean	Mean
Farmer age (years)	59.81	13.31	58.86	59.89
Farmer education (degree)	3.72	1.52	4.09	3.69
Farmer gender (1 = female, 0 male)	0.22	N.A	0.15	0.22
Location (1 if farms located in south of Italy)	0.50	N.A	0.47	0.50
Conduction (1 if farms without employed workers, 0 otherwise)	0.67	N.A	0.52	0.69
Quality certification (1 = presence, 0 otherwise)	0.03	N.A	0.06	0.02
Organic certification (1 = presence, 0 otherwise)	0.03	N.A	0.04	0.03
Investment in the last 5 years (1 = yes, 0 otherwise)	0.33	N.A	0.39	0.33
Land property (€/ha)	61.31	120.65	83.91	59.48
Farm UAA hectares	59.82	77.37	91.73	57.25
Intensity of mechanization (kw/ha)	5.97	5.63	4.92	6.05
Irrigation (1 = presence, 0 otherwise)	0.07	N.A	0.09	0.07
Gross sales (per hectare)	1107.95	742.60	1234.11	1097.77
Relative profit differences	1.37	2.39	2.53	1.28
Fixed costs (per hectare)	244.68	262.35	232.39	245.67
Variable costs (per hectare)	646.16	517.83	697	642.06
Wheat—yield (q.ls/ha)	37.83	12.30	38.34	37.79
Wheat—gross sales (per hectare)	921.53	387.65	1021.81	913.44
Wheat—gross margin (per hectare)	566.45	374.75	669.06	558.17
Wheat—variable costs (per hectare)	355.09	173.79	352.75	355.28

N.A not applicable

$$p(x_i) = \Pr[VC_i = 1|x_i] \tag{2}$$

Given VC_i and x_i, the conditional probability of observing the treatment status (propensity score) or the probability of observe farms being vertical integrated, $p(x)$, can be calculated by implementing, for example, a probit regression.

$$\Pr[VC_i = 1|x_i] = \Phi(x_i'\beta), \quad i = 1, \ldots, 2450 \tag{3}$$

where Φ represents the cumulative distribution function of the standard normal distribution.[1]

Once a propensity score estimation is computed, the next step is to match the treated (vertically coordinated farms) to a control group (non-coordinated farms) based on the estimated propensity score (Lombardi et al. 2015; Pascucci et al. 2016; Caracciolo and Furno 2017). Only those farms that have a similar propensity of being vertically coordinated were compared. Following Dehejia and Wahba (1999, 2002), this paper uses the *stratification* matching method. Moreover, in order to measure the differences, or average gain, from the farms selling all or part of their products directly to the industry (vertical coordination) and non-coordinated farms, average treatment effect on the treated (ATET) was computed.

$$\mathrm{ATET} = E[\Delta \mathrm{Y_i} | p(\mathrm{x_i}), \mathrm{VC_i} = 1] \quad (4)$$

Data

Sample investigated in this paper was retrieved from the Italian Farm accounting data network (FADN) database.[2] More in detail, economic and structural information regarding the farms belonging to three distinct types of farming (TF) specialized in arable crops were collected from the year 2008 to the year 2011 (Table 1).

However, only farms producing durum wheat were included in the assessment, for a total of 2450 observations. Within the sample, vertical coordination was observed in 183 farms (about 7.5% of the sample).

Table 1 shows the farmers' socio-demographic profile and the farms economic and structural characteristics involved in the study. Age, education level, and gender were measured for the farmers. At farm level, UAA, presence of irrigation, intensity of mechanization, presence of certifications, and wheat yield were recorded. Moreover, assets (including land) and structure of costs (fixed and variable costs per hectare) and returns (gross sales, gross margin) were measured. Of all the wheat producers included in the sample, 22% are female (15% in coordinated farms), the average age is 60 years (in the range 22–98 years). As regards education, the 9% of the agricultural producers are educated to a higher level (12% in coordinated farms). About half of the farms (49.8%) are in the South of Italy (including Sicily and Sardinia), while this percentage is slightly lower for coordinated farms (47%). Regarding structural characteristics, average utilized agricultural area is approximately 60 ha (83 ha for coordinated farms), while average annual gross sale is valued at €1108 per hectare (€1234 per hectare for coordinated farms). Finally, about the 3% of the sampled farms have been awarded a quality certification (the 6% for coordinated farms), while about the 67% of the farms are conducted without employed workers (the 52% for coordinated farms).

Results

Propensity score estimates

An econometric model was implemented to calculate the probability of being vertically coordinated or propensity score. In particular, propensity score was estimated using a probit model including both farms structural and economic characteristics and farmers socio-demographic profile where the dependent variable assumes value 1 if the farm resulted vertically coordinated and 0 otherwise (Table 2). The variables included in the model closely correspond to those previously recognized as notably different among the two groups of farmers. Furthermore, regional-fixed effects were added to the specification in order to control regional unobservable characteristics.

Results indicate that the propensity for a farm to be vertically coordinated is influenced as follows: large land size, the presence of product or process certification, and a high level of education of the entrepreneur increase the probability for a farm to be vertically coordinated. On the contrary, female entrepreneurship and the absence of salaried employees decrease the farms propensity to be vertically coordinated (Table 2).

Figure 1 illustrates the estimated probability for a farm to be vertically coordinated. This varies from 0 to 1, and it has been calculated considering the characteristics of an averaged durum wheat farm: Values close to zero indicate scarce propensity for a farm

Table 2 Vertical coordination participation model (probit with regional fixed effect)

Variables	Prob[*Y* = 1]; *1: coordinated farm*
UAA: hectares	0.002***
	(0.001)
Certification: 1 if product and/or process certified	0.460**
	(0.19)
Gender: 1 if female farmer	−0.260**
	(0.11)
Conduction: 1 if farms without employed workers	−0.160*
	(0.10)
Age: years	−0.001
	(0.01)
Education: degree	0.054*
	(0.03)
Constant	−1.68
	(0.30)

Observations 2450; standard errors in parentheses
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

to be vertically coordinated, while values close to 1 indicate high propensity. A detailed analysis of the figure highlights that only very large farms show on average a high tendency to be vertically integrated. Indeed, a land size larger than 400 ha (on average) for highly educated farmers or higher than 700 ha for those poorly educated represent an ambitious threshold that may currently reach only a small minority of farms in Italy as documented also by FADN sample statistics.

From the propensity score estimation, groups including coordinated and non-coordinated farms that share similar observable characteristics are generated, making sure that each group benefits the balancing property. Thus, only a subset of the original

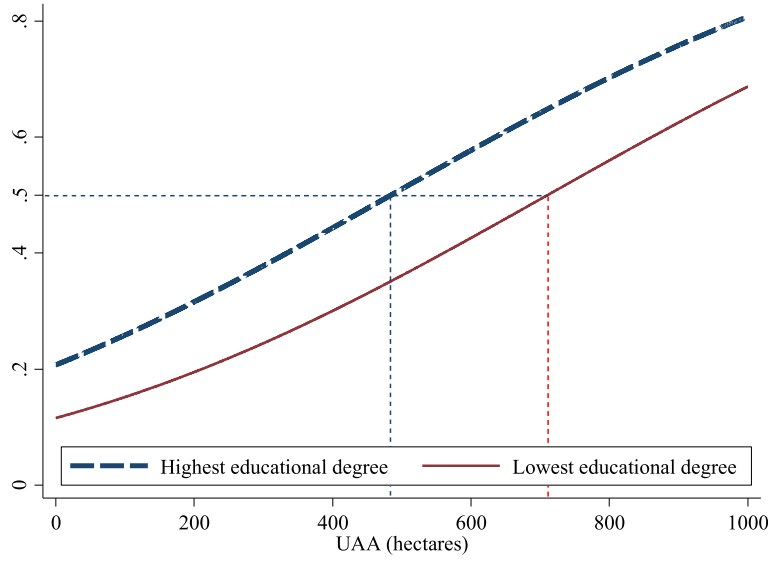

Fig. 1 Estimated function of propensity for a farm to be vertically coordinated

sample was considered for the matching. The area of common support (similar propensity scores) between coordinated and non-coordinated groups resulted to be 94%, corresponding to 2314 farms over the 2450 included in FADN, and the balancing property was satisfied at significance level of $p < 0.10$. This was fulfilled following Becker and Ichino (2002) approach: it implies that (i) within each group that the average propensity score of treated and untreated farms do not differ and (ii) that the means of each variable do not differ between treated and untreated farms.[3] Moreover, following Smith and Todd (2005) after-matching balancing test was performed by testing for the joint equality of covariate means between treated and-untreated groups (Hotelling's test[4]). Null hypothesis of equality of the means cannot be refused at the 10% level of significance.

ATET estimation

Tables 3 and 4 show the estimates for the average treatment effect on the treated (ATET) based on the propensity score and the stratification matching method. In order to assess which economic performance measures showed a significant difference between coordinated and non-coordinated farms, a *t* test was carried out as shown in the tables.

Briefly, ATET estimates show a positive effect of the vertical coordination on the overall gross sales (+ 160 € per hectare) and on the specific durum wheat measures: vertical coordination effects on gross sales and gross margin are positive and are respectively + 114 € and + 120 € per hectare. As concerns the profitability measure (RDP), the ATET of being vertically coordinated is positive (about + 0.57, representing an increase of around 44% compared with the mean RPD value of non-coordinated farms equal to 1.28) and statistically significant. As for the variables related to the costs (fixed and variable) and durum wheat yield, they do not seem to be significantly affected by vertical coordination. Our results highlight that coordinated durum wheat farms, showing the same yields and costs, may benefit of higher market prices when compared with non-coordinated ones. Several possible interpretations can be given on why vertical coordination may provide higher market prices to farms. Vertically coordinated farms benefit a shorter value chain, and this condition may help them to gain a greater share of the total returns. Moreover, vertical coordination in the pasta supply chain is mainly driven by the industry through contract farming: these contracts are generally designed in order to fit quality standards dictated by the market, including sometimes farms obligations to particular requirements (e.g., use of certified seed varieties, adoption of rotations, and specific agronomic practices), helping farmers to seize new market opportunities. In particular, the increased awareness of the food consumers towards the quality characteristics of raw material is fostering also Italian pasta

Table 3 ATET on farm profitability measures (method: stratification)

Outcomes	RPD	Gross sales[a]	Fixed costs[a]	Variable costs[a]
ATET	0.59**	160.21***	7.78	64.56
	(0.28)	(63.51)	(17.37)	(48.09)
Observations	2314 (treatment no. 183; control no. 2131)			

Standard errors in parentheses
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$
[a]Per hectare

Table 4 ATET on durum wheat profitability measures (method: stratification)

Outcomes	Gross sales[a]	Variable costs[a]	Yield[a]	Gross margin
ATET	114.62**	5.60	0.968	120.23**
	(47.10)	(14.14)	(1.185)	(51.79)
Observations	2314 (Treatment no. 183; control no. 2131)			

Standard errors in parentheses
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$
[a]Per hectare

producers to assure durum wheat that may seize the consumers' demand of local and traditional food. Thus, vertical coordination may be seen, to some extent, as a possible path towards the de-commoditization strategy (Caracciolo and Lombardi 2012).

Discussion and conclusions

The aim of this research was to test the economic benefits of two types of supply chain relationships (vertically coordinated and non-coordinated), verifying their influence on farms' performance. A propensity score matching (PSM) model was implemented to estimate the average effect of vertical coordination on a representative sample of Italian farms specialized in durum wheat production. To compare outcomes of treated and un-treated farms, we utilized some measures of farming activity, such as gross sales, gross margins, costs, yields, and an index of overall profitability adjusted by farm efficiency (Boone 2008). By using PSM method, we also identified those farm characteristics that could explain their different likelihood of being vertically coordinated.

Results show that in case of coordination, Italian durum wheat producers are better off in terms of gross sales and gross margins. Such performances determine improvements of overall farm profitability. It also shows that costs structure and production yields are not affected by vertical coordination. These findings suggest that coordinated relationships with processors allow farms to increase their bargaining power, obtaining high prices without incurring in higher costs.

Looking at the results of the probit model implemented to compute the propensity scores, we can verify that farms with a higher probability of being vertically coordinated are, on average, larger in size, adhering to certification schemes for products or processes, engaging prevalently salaried workers and they are more frequently managed by male and highly educated farmers. Summarizing, vertically coordinated farms are more sized and professional and have a greatest focus on quality and receive, ceteris paribus in these characteristics, and benefits through highest market prices.

Several policy interventions were adopted in Italy in encouraging more coordinated vertical relationships, aiming to improve the functioning of the national food supply chains and to create value in local rural economies. The ratio of these policies is substantially based on the idea, supported by mainstream literature, that coordinated relationships in the supply chain are particularly advantageous for small farms allowing them to mitigate market risks and face the market failures, such as the lack of innovative strategies, as well as poor access to credit and insurance and so on. However, based on our findings, it seems that these interventions could not effectively push smaller and less structured farms in engaging vertical contracts. This is an important issue considering that the Italian primary production system is characterized by the prevalence of very small farms. Probably other specific interventions, for example based on

information, training and dissemination of the expected benefits from coordination, should increase farmers' willingness to join contract farming. In this respect, we must emphasize that our study is not able to explain why farms, with the same likelihood of being coordinated, do not participate to supply chain network, although it seems that positive effects arise from coordination. It is, then, implicit the influence of other latent individual characteristics (such as competence of entrepreneurs, risk aversion, technical skills, networks embeddedness, etc.) that could affect the farm willingness to subscribe contracts. Not surprisingly, some research conduct in Europe evidenced a positive influence of cooperative structure on farmers' participation to vertical networks (Deimel and Theuvsen 2011). Consistent with these evidences seems to be the last CAP reform that has renewed and increased the role for Producer Organizations by introducing new interventions in Rural Development contest. However, other studies on this subject should be conducted in Italy, to provide more and deeply evidences on the recent dynamics of agri-food chains and to support policy makers for more appropriate interventions.

Endnotes

[1]This specification assumes error term normally distributed with mean 0 and variance 1. A non homoscedastic assumption, specifically, variance as function of utilized agricultural area, was also tested. The likelihood-ratio test of heteroskedasticity was not significant with $\chi^2(1) = 2.71$.

[2]The Italian FADN sample is representative of national universe of farms, excluding those being smaller than €4800 of standard gross margin (SGM). SGM is calculated as difference between the standard values of total production and direct costs. Starting from 2009, this threshold was changed in €4000 of standard output (SO), that is a standard value of total farm production. More details are available from http://bancadatirica.crea.gov.it/Default.aspx

[3]As illustrated by Becker and Ichino (2002), this approach can be considered conservative since the significance level applies to the test of each single variable of the of pre-treatment characteristics, i.e., the balancing property is not rejected only in case it holds for every single variable.

[4]Given two groups, g_1 and g_2 respectively characterized by $n_1 + n_2 = n$ observations, in order to test that the means of k variables are 0, let $\boldsymbol{\mu_1}$ be a $1 \times k$ matrix of the means of the variables in g_1, $\boldsymbol{\mu_2}$ a $1 \times k$ matrix of the means of the variables in g_2 and $\boldsymbol{\Sigma}$ be the estimated covariance matrix.Then $T^2 = (\boldsymbol{\mu_1} - \boldsymbol{\mu_2})\, \boldsymbol{\Sigma^{-1}} (\boldsymbol{\mu_1} - \boldsymbol{\mu_2})'$ and $(n\text{-}k\text{-}1)/[(n\text{-}2)\, k\, T^2] \sim F(k, n\text{-}k\text{-}1)$.

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Authors' contributions
This work was carried out with the contribution of all listed authors that approved the final version.

Competing interests
The authors declare that they have no competing interests.

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