Vertical integration in agribusiness. Is it a bargain ?

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Abstract

This paper aims to test whether vertical integrated farms show a significant higher economic performance when compared with those not integrated. The Italian Farm Accountancy Data Network was used, for the years 2008-2011, focusing on farms producing durum wheat. Empirically, a propensity score-matching model was implemented in an attempt to estimate average differences, in some farm performance indexes, including costs and profitability, between vertical integrated and non-integrated farms. The analysis on the effects of a vertical integration showed that supply chain integration increases farms' competiveness and profitability.)

Keywords
vertical integration, farm competitiveness, propensity score matching, FADN

Introduction

Vertical integration in agribusiness is widely considered as a promising opportunity for value creation in rural economies and agri-food industry (Barney and Hesterly, 2011). While it could support farmers in their effort to leave the perimeter of commodities through retaining bigger share of the value chain (Caracciolo & Lombardi, 2012), supply chain integration is deemed as a necessary strategy to optimize the production system, helping agri-food industry to face the global competition (Bertazzoli et al., 2009). The theme of integration in agribusiness is relevant either in academic, business and policymaking communities (Seuring and Muller, 2008; Martino et al., 2012).
One common feature of supply chain integration, gathered by the several definition available in the literature, can be summarized as follow: integration is the process of progressive dependence among different actors that brings to common investments, coordination of activities, and processes of learning and innovation (Handfield and Nichols, 1999; Hugos, 2003). Integration may appear in different forms, changing on a case by case base, showing different intensity of coordination of cooperation and trust (Baldi, 2013). It can be based on agreements (formal or informal), including cultivation contracts, that may also lead to the development of unusual organizational frameworks such as industrial clusters, alliances,

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and/or joint ventures (Menard, 2012). What emerges, though, is the need for (complex) forms of chain organization driven by organizational and contractual innovation (Freeman, 2010). This is particularly true when a potential rise of conflicting values among actors take place when agreeing to participate, through integration, in a model of common business involving economic performance of a wide range of stakeholders (Rittel and Webber, 1973; Conklin, 2006). Though a positive effect of the integration is expected in the supply chain, to the best of our knowledge, it is still unclear the magnitude (if any) of the bargain at farm level. To that extent, the research question we try to address concerns the farms' economic benefits of being involved in processor driven integration.

Among the different forms of vertical integration, in Italy, a particular form of vertical integration in the pasta supply chain is coming out. It is characterized by an overall framework agreement signed by the main stakeholders involved in the supply chain (farmers, seeds and chemicals producers, dealers and food industry) sustained and supported by policy measures (within the programs for rural development). Within this framework agreement, the formal relations with durum wheat producers and pasta industry are regulated by contract farming designed in order to set not only the pricing mechanism (combining price to quality standards), but also the definition of a minimum volume of product to be delivered by farmers, and provisions and obligations for transferring production technologies and inputs (seeds, fertilizers and chemicals). The advantages are diverse: While farmers may reduce price risk volatility by subscribing a minimum price guaranteed contract, industry can count on a stable supply in terms of quantity and quality. Moreover, farms may reduce transaction costs related to the search for buyers and may benefit of technical assistance, the latter representing a certainty advantage for farms with limited economic size usually unable to access to private agricultural extension services. On the other hand, farming practices obligations and stringent quality requirements, that affect overall price generation, may represent a serious risk for farmers of being legally trapped into a detrimental agreement due to the monopsonistic power of the industry. The latter aspects may partly explain the resistance to adhesion by farmers (Cembalo et al., 2014a). Pasta supply chain represents therefore an interesting case study for assessing whether vertical integration is really a bargain for the involved farmers. Consistent with this premise, our study covers farms specialized in durum wheat production by examining a large representative sample of farms present in the Italian FADN (Farm Accountancy Data Network).

In order to assess whether vertical integrated farms experience higher economic performances than those non integrated, a propensity score matching (PSM) model was implemented in an attempt to estimate average in some revenue/costs/profitability indexes of Italian farms specialised in the production of durum wheat between integrated and non-integrated farms.

Since farms' integration is not randomly assigned, the choice of participating to a contract scheme may depend on a number of farms characteristics that are, in turn, related to the measures of profitability. Propensity score matching allows to take into account these observable variables, matching integrated farm with a subsample of non integrated ones that show similar probability to be vertical integrated (also known as propensity score).

Results provide evidence to the belief that farms benefit from vertical integration in terms of gross sales and farms profitability (in terms of relative profit differences). Moreover, integration does not affect the burden of variable and fixed costs: vertical integration seems not to significantly change farms' production organization.

Methodology

The modelling approach implemented sought to estimate average differences, in farms competitiveness and profitability, between vertical integrated and non-integrated farms. The first methodological step involves the design of the farms' profitability measure throughout the information provided by the FADN. Indexes have to, by their nature, be based on a case-by-case base since they need to by functionally consistent with the aim of the analysis in hand. For each of the 2,450 farms reported in the Italian FADN, in the years from 2008 to 2011, Gross sales, Net Income, Variable Costs and Fixed costs per UAA hectares were computed. Starting from those basic indexes, a farm competitiveness and profitability measure was computed, namely the Relative profit differences (RPD). RPD is a measure of competition characterized by a robust theoretical foundation first proposed by Boone (2008). RPD is a normalized measure of farm profitability adjusted by farms efficiency. To illustrate, assuming that farms are ordered such that the economic efficiency of farms is decreasing in i (with i being the i-th farm in the sample), RPD can be calculated as:

$$RPD_i = \frac{\pi_i - \pi_N}{\pi_1 - \pi_N} \quad (1)$$

Where π_1 is the profit corresponding to the farm with the highest efficiency, while π_N corresponds to the profit of the least efficient farm. Boone proposed the average variable costs as a measure of efficiency. In our analysis Variable Costsi/Gross salesi ratio was used instead, where Gross Sales were computed by summing up the whole sale coming from all agricultural products sold by the i-th farm. Together with the RPD, an index at farm level, a set of measures specifically computed on durum wheat production, where taken into consideration. They are: durum wheat Gross sale, Gross margin (gross sales minus direct production costs), yield per hectare, and Variable costs.

The second methodological step relates to the PSM. In order to illustrate this statistical procedure, it is worth spending some words on the overall approach. Data were treated in the framework of quasi-experimental studies. The latter term comes from behavioural economics and non-statistically oriented literature (Shadish et al. 2002). More explicitly, one of the main features of quasi-experimental studies concerns the so-called treatment effects. An observational study shares, with a purely experimental one, the same purpose but, unlike an experiment, no method of experimental design is implemented to maintain a control group (Guo and Fraser 2010). In this context, treated and control groups (also termed counterfactual) may show large differences in terms of covariates, such as farm size or farmer education for example, yielding biased estimates of treatment effects. This kind of study is necessary when randomised assignment of treated and non-treated groups are

infeasible, unethical, or when researchers need to assess differences between groups under particular marketing strategy settings. The latter motivation is one of the main critiques of social experiments made by econometricians. Heckman and Smith (1995), for instance, argue that randomisation is unfeasible, or non-desirable, when institutions and social environments are part of the decisional process and are therefore relevant when the purpose of the study is to design policy intervention following a behavioural economics analysis (Heckman 1979; Heckman and Smith 1995). In quasi-experimental studies, where the task is to evaluate treatment effects in a non-randomization approach, in order to reduce the multidimensional information (namely farm/farmers variables) to only one score, it is worth invoking the so called propensity score. Since the seminal work of Rosenbaum and Rubin (1983) on propensity score analysis, this method has become increasingly popular in quasi-experimental studies. The propensity score approach has been implemented in many disciplines such as psychology (Jones et al. 2004), medicine (Earle et al. 2001; Gum et al. 2001), education, social work (Barth et al. 2007; Weigensberg et al. 2009), and social welfare studies (LaLonde 1986; Michalopoulos et al. 2004). When participation in a supply chain is not randomly assigned but stochastically depends on a number of observable variables, the propensity score can be implemented as a measure of conditional probability of participation conditional upon the observed variables (farm and farmer characteristics). Let x be the observable variables, and p(x) the conditional probability of treatment participation (or propensity score):

$$p(x) = \Pr[D = 1|X = x] \tag{2}$$

Given D_i and x_i, the propensity score can be calculated by implementing, for example, a logit regression (Cameron and Trivedi 2005). Once a propensity score estimation is computed, the next step is to match the treated (vertical integrated farms) to a control (non-integrated farms) group based on the estimated propensity score. The intuition behind matching is to generate a new data sample built by only those cases that share a similar likelihood of being vertical integrated. This likelihood is the propensity score. The most common matching algorithm is the greedy matching. There are many methods to achieve greedy matching (D'Agostino 1998; Smith and Todd 2005; Guo and Fraser 2010). The method implemented in this paper follows that implemented in Dehejia and Wahba (1999; 2002). The core idea starts from a widely used measure of treatment effects that can be calculated as treatment evaluation: Average Treatment Effect on the Treated (ATET). In the specific case of our study we consider a group of farms that sell all or part of their products directly to the industry (vertical integration). ATET measures the differences, or average gain, from those farms and non-integrated farms (Heckman and Vytlacil 2007).
In our study, following Dehejia and Wahba (1999; 2002), we estimated a logit model on the probability of being vertical integrated:

$$\Pr[\mathrm{Int}_i = 1|x_i] = \Lambda(x_i'\beta), \quad i = 1, \dots, 2450 \tag{3}$$

where $\Lambda(z = x_i'\beta) = e^z/(1 + e^z)$, while the regressors are some farm and farmers characteristics (reported in table 1). Any matching method involves tradeoffs between the

number of matches and the quality of matching, and none is clearly superior to the others. Hence, from a general specification of the ATET, we chose to estimate stratification method following Dehejia and Wahba (1999; 2002). In order to verify which variables showed a significant difference between the two groups, a *t*-test was performed.
As stated above, propensity score matching is a sound tool to net out the effect of the treatment. It is worth specifying the concept of treatment for vertical integrated farms. Treatment is a general term used in the literature of observational or quasi-experimental studies. In our case, participating in an integrated supply chain involves a set of decision making processes able to add value to a supply chain through new relations among stakeholders. Of particular interest is the ability of these stakeholders to develop a sense of cooperation, through ties of reciprocity, and construct relational structures able to generate value and efficiency in the supply chain. Although one cannot talk of a treatment as such, participation in a vertical integration framework, for the reasons stated above, has a non-neutral effect on the same participants, as if participation was an actual treatment exercised by the agents (individuals) participating at the integrated supply chain.

Data and Results

Data used in the analysis comes from the Italian Farm accounting data network (FADN) database[1]. Records from farmers belonging to 3 distinct types of farming (TF) specialized in arable crops were collected from the year 2008 to the year 2011 (Table 1).
Within this subset, only farms producing durum wheat were considered in the analysis. A total of 2,450 farms were included in the sample. Vertical integration was observed in 183 farms representing about 7.5% of the sample.
Table 1 reports the farms structural and economic characteristics and farmers socio-demographic profile involved in the analysis. Age, education level, gender and entrepreneur status where measured for the farmers. At farm level, utilized agricultural area, presence of livestock, land and other capital assets, presence of irrigation, subsidies beneficiary and working intensity (hours) were also measured. Of all the agricultural producers included in the sample, 21 percent are female (15% in integrated farms), the average age is 59 years (in the range 22–98 years). As regards education, the 9 percent of the agricultural producers are educated to a higher level (12% in integrated farms). About half of the farms (49.8%) are located in the South of Italy (including Sicily and Sardinia), while this percentage is slightly lower for integrated farms (47.5%) With regard to structural characteristics, average utilized agricultural area is approximately 61 hectares (92 hectares for integrated farms), while average annual gross sale is valued at € 1,107 per hectare (€ 1,107 per hectare for integrated farms). Finally, about the 3 percent of the sampled farms have been awarded a quality certification (the 6 percent for integrated farms). Only explanatory variables statistically significant were left in the Logit model where the dependent variable assumes value 1 if the farm resulted vertically integrated and 0 otherwise (Table 2).

[1] Data are available from http://bancadatirica.inea.it/

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

Variables	*Vertical Integrated farms* (obs. 183)		*Non-Integrated farms* (obs. 2267)	
	Mean	std.dev	Mean	std.dev
Farmer age (years)	58.86	12.81	59.89	13.35
Farmer education (degree)	4.09	1.58	3.69	1.51
Farmer gender (1 = female, 0 male)	0.15	N.A	0.22	N.A
Quality certification (1 = presence, 0 otherwise)	0.06	N.A	0.02	N.A
Organic certification (1 = presence, 0 otherwise)	0.04	N.A	0.03	N.A
Investment in the last 5 years (1= yes, 0 otherwise)	0.39	N.A	0.33	N.A
Land property (€/ha)	83.91	128.35	59.48	119.85
Farm UAA hectares	91.73	97.02	57.25	74.99
Intensity of Mechanization (kw/ha)	4.92	5.07	6.05	5.67
Irrigation (1 = presence, 0 otherwise)	0.09	N.A	0.07	N.A
Gross Sales (per hectare)	1,234.11	703.48	1,097.77	744.88
Relative profit differences	2.53	3.19	1.28	2.29
Fixed costs (per hectare)	232.39	209.30	245.67	266.18
Variable costs (per hectare)	697.00	468.57	642.06	521.48
Wheat - yield (q.ls/ha)	38.34	13.86	37.79	12.16
Wheat - Gross Sales (per hectare)	1,021.81	576.62	913.44	367.19
Wheat - Gross margin (per hectare)	669.06	556.21	558.17	354.99
Wheat - Variable costs (per hectare)	352.75	168.88	355.28	174.21

Table 2 - Vertical integration participation model (logit with regional fixed effect)

Variables	Prob[Y=1]; *1: Integrated farm*
UAA: hectares	0.003***
	(0.00)
Certification: 1 if product and/or process certified	0.922***
	(0.36)
Gender: 1 if female farmer	-0.522**
	(0.22)
Conduction: 1 if farm conducted with salaried	-0.366*
	(0.19)
Age: years	-0.001
	(0.01)
Education	0.118**
	(0.06)
Constant	-16.109
	(516.84)
Observations	*2,450*

*Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*

From the propensity score estimation, we obtain groups with different numbers of treatment and control units, making sure that each groups benefit of the balancing property: both the average propensity score and the average for each explanatory variable between treated and controls have to be equal. As a result, only a portion of the original sample was taken into account. The area of common support (similar propensity scores) between integrated and non-integrated groups resulted to be 96%, corresponding to 2,327 farms over the 2,450 included in FADN, and the balancing property was satisfied at significance level of $p < 0.01$.
Results reported in the table 2 suggest that probability to be integrated depends on the farm's size and by the level of education, while farms owned by female entrepreneurs are less likely to be vertical integrated. Finally, it is worth noting that the presence of certification positively influences the probability of a farm to be vertical integrated.
Table 3 and 4 report the estimates for the average treatment effect on the treated (ATET) based on the propensity score matching method. Results support the hypothesis that vertical integration has a positive impact on the farms profitability.

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

Outcomes	RPD	Gross Sales^	Fixed Costs^	Variable Costs^
ATET	0.60**	167.77***	6.52	68.42
	(0.27)	(63.53)	(17.79)	(48.81)
Observations	2,327 (Treatment # 183; Control #2,144)			

*Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.*
^ per hectare

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

Outcomes	Gross Sales^	Variable Costs^	Yield^	Gross Margin
ATET	130.72***	1.42	4.64	126.08***
	(43.43)	(0.98)	(16.03)	(43.67)
Observations	2,327 (Treatment # 183; Control #2,144)			

*Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.*
^ per hectare.

To illustrate, results show a positive effect of the vertical integration on the overall Gross Sales (+168€ per hectare) and on the specific durum wheat measures: Gross Sales and Gross Margin are respectively +131€ and + 126€ per hectare. As concerns the relative profit differences, the difference in ATET between integrated and non-integrated groups are positive (about +0.60, representing an increase of around 40% compared with the mean RPD value of non integrated farms) and statistically significant. As for the variables related to the costs (fixed and variable) and durum wheat yield, they do not seem to be affected by vertical integration. These results, confined at the durum wheat sector, suggest that integrated farms, showing the same yields and costs, may benefit of higher market prices when compared with non-integrated ones. Several interpretations can be given on why

integrated farms may benefit higher market prices. Vertical integration implies a shorter value chain and this condition may foster agricultural producers to achieve a greater share of the total returns. Moreover, vertical integration in the pasta supply chain is mainly driven by the industry through contract schemes: these contracts are designed in order to maximize quality standards recognized by the market, including sometimes farmers obligations to particular requirements (e.g. use of certified seed varieties, adoption of rotations and specific agronomic practices), providing economic incentives for the farmers. In particular, the increased awareness of the food consumers towards the quality characteristics of raw material is fostering also Italian pasta producers to assure durum wheat that may seize the consumers' demand of local and traditional food. Thus, vertical integration may be seen, within a certain degree, as an important component of de-commoditization strategy for providing a premium price to agricultural producers (Caracciolo and Lombardi, 2012).

Conclusions

In this paper we have presented an empirical study aiming at measuring the effect of vertical integration on farms economic performance. Given the time span and type of farming considered, results indicate that vertical integration provides higher economic benefits to farmers.

Estimates provide evidence to the belief that farmer may benefit from vertical integration in terms of gross sales and overall farms profitability (in terms of relative profit differences). Moreover, integration does not affect the burden of variable and fixed costs: vertical integration seems not to significantly change farms' production organization. Thus, results may suggest that farms establishing integration relations with the processing industry are more committed to exert effort to pursue quality improvement of their products and, consequently, to benefit higher prices on their market. This goal seems being reachable without a deterioration of the costs structure and / or a reduction in yields.

Our empirical results, however, should be treated with caution. Further investigation should enlarge the time span considered and farming typology. From a methodological point of view, some problems could derive from the ATET computations using PSM model, because PSM solves the selection bias associated to observable variables, while it cannot take into account unobservable characteristics of the farm/farmer that could also affect selection as well. Further studies could be performed to refine the PSM procedure, controlling for the unobservable source of selection bias. Another question to be addressed, left to further researches, concerns the individual propensity to integrate. In other terms, if the farm-level benefits of integration are so attractive, why are many farmers still unwilling to participate in this type of vertical integration? This work is not able to answer to this question. While our study confirms a comparative advantage to be vertically integrated in a supply chain, it does not explain why those farms with the same likelihood to be integrated do not act in that direction. A number of studies are merging economic and sociological paradigms to cover this lack of knowledge. Recent studies that investigates wheat producers willingness to join contract farming in Italy (Cembalo et al., 2014b) reported that, especially in some production environments, the presence of information asymmetries could be the main constraint to the

establishment of contract farming based integration. Moreover, in some context, the small farming dimension may discourage processing industry to establish contractual framework that are not able to supply enough quantities of wheat for the industry purpose. We believe that this field is still underexplored.

Policy implication could be depicted from our results. A number of policy measures were already introduced to facilitate the development of such forms of contracts, providing co-financing support as well other forms of incentives to the actors involved to the partnership. However, specific policy interventions are needed to increase farmers' willingness to join contract farming, through information activities, training and dissemination of the expected positive benefits. Furthermore, in the light of a greater importance that supply integration will have in the future, policy makers should be aware that a sizable part of the value creation through integration remains at farm level. This is not a trivial result if one things that distribution of benefits along a supply chain is often an issue, being farmers very often the weak side of valuable chains. However, future investigations on this topic are needed seen its relevance for farmers and rural areas at large.

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