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Efficiency and Capital Structure in the Italian Cereal Sector

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1. Introduction

Farm capital structure may have contrasting effects on farm efficiency as a strand of the farm efficiency literature as pointed out (for a review see for example Davidova and Latruffe 2007). Farmers often use external funding both to cover productions costs and to finance investments (machinery, equipment, buildings) to enhance farm economic performance. The debt is necessary to maintain or improve farm productivity and competitiveness by adopting technological innovation needed to increase farm efficiency. At the same time leverage may affects farm efficiency by influencing farm production decision constrained by lower farm expenditure capacity. In this case, farms response may rely on reducing the necessary expenditures to maintain the production assets with negative consequences on farm productivity, growth and efficiency. Finally, farm leverage may affects the farms capacity to react to market shocks adopting the needed strategic adjustments to maintain productivity, efficiency and competitiveness. A relevant case study for assessing this last effect would be the recent surge in price volatility that affected European and world cereal markets starting from 2008.

The objective of this paper is to provide new empirical evidence on the relationship between farm capital structure and farm efficiency. In particular we will try to answer the following research question: does higher leverage lead to better performance? The food price volatility that has affected the cereal market from 2008 onwards is a possible stress for cereal farms that must adapt to the rapid drop in prices such as the one observed in 2010. Our research provide a first insight on the evolution of the cereal farms debt-technical efficiency relationship in times of high price volatility.

The paper is set out as follows. In Section 2, we review the literature on farm capital structure and farm efficiency. In section 3, we present data, methods and the regression model. Section 4 focuses on the model results and section 5 provides some conclusions.

2. Farm performance and capital structure

In recent years a noticeable number of papers have been published on the relationship between capital structure and technical efficiency in the farm sector. Several theoretical explanations, often predicting contrasting evidence, have been put forward to explain the existence, if any, of a direct relationship between measures of indebtness such as the leverage[1] or debt to asset ratio (DAR) and technical efficiency (TE). A first rough classification distinguishes between general theoretical explanation, valid also for other sectors and farm specific explanations.

The Fisher separation theorem states that, under perfectly functioning financial markets, financial and investment decisions are independent. As a consequence, technical efficiency which depend on investment decisions should not be related to the way investments are financed (Lambert and Bayda, 2005).

[1] Leverage in this context is defined as the ratio of debt over investments

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As the hypothesis of perfectly functioning financial markets is a rather restrictive one, especially in times of credit rationing, a number of alternative theoretical explanations have been advanced: free cash flow, agency cost and credit evaluation.

The free cash flow model (Jensen, 1986) posits that higher leverage reduces inefficiency by inducing stricter discipline on relaxed management which waste the abundant financial resources in self-serving objectives against the interest of the principal (the ownership). High debt ratios reduce the waste of cash by managers either through the need to generate cash to repay the debt or through the menace of liquidation. In the farm context where management and ownership is usually reunited in the same subject, the farmers are agents urged by lenders (principals) to exert greater effort to be able to repay the debt (Barry and Robinson, 2001).

The agency cost model (Jensen and Meckling, 1976) posits a negative relationship between indebtedness and efficiency in a context of imperfect information as lenders transfer to borrowers the cost of monitoring thus raising the costs of indebted farms. These additional costs are likely to reduce the technical efficiency of the affected farms in comparison with less indebted ones.

The two approaches so far mentioned both hypothesizes a casual relationship (even if with opposite direction) from indebtness to technical efficiency. The credit evaluation hypothesis- also known as the efficiency risk hypothesis- postulates instead a reverse causation relationship where efficiency causes higher leverage as banks prefer borrowers with a low risk of financial distress. Technical efficient firms may easily borrow as they are more likely to repay the debt. The empirical relevance of this mechanism should be more salient in contexts where loan applications are usually evaluated according to solvency, repayment capability, profitability management ability and other financial and managerial variables. Conversely where loan are granted mainly on the availability of adequate collaterals, the hypothesis is less relevant (Davidova and Latruffe 2007)

Other hypothesis on the indebtedness TE relationship are specific to the farm sector: the capital embodiment theory and the adjustment cost theory. Chavas and Aliber (2003) note that technical change in agriculture is often embodied in intermediate and long run assets such as machinery or new orchard varieties. If this is the case then productivity improvements can be attained only investing in the new technical assets which are often purchased resorting to debt. According to this theory more indebted farms should have a renovated technical capital and show higher technical efficiency.

The adjustment theory was first proposed by Morrison Paul et al. (2000) in discussing the impact of the 1986 liberalization reform of the Agricultural Policy in New Zealand. According to this theory the financial constraints faced by indebted farms reduced their ability to adjust the new deregulated environment thus decreasing their efficiency. In this case a negative relationship between indebtedness and TE is assumed.

Summing up a variety of theories providing opposite predictions have been put forward to explain the DAR-TE relationship in the farm sector. Empirical evidence is mixed as far as the sign and the direction of the relationship are concerned as it is shown by table 1 where we synthesize the results of a few papers on the subject .

Table 1 Empirical findings on the relationship between Debt to asset ratio (DAR) and Technical Efficiency

Authors	YEAR	COUNTRY	DIRECTION of relationship	SIGN of relationship
Lambert D.K & Bayda V.V.	2005	USA	debt -> TE (assumed)	- (short term DAR) + (intermediate DAR)
Mugera and Nyambane	2014	Australia	debt -> TE (assumed)	+ (short term DAR) 0 (long term DAR)
Chavas and Aliber	1993	USA	debt -> TE (assumed)	0 (short term DAR) + (intermediate DAR) + (long term DAR)
Hadley	2006	UK	debt -> TE (assumed)	- (DAR)
Davidova S. Latruffe Laure	2007	Czech Rep.	debt -> TE (tested and rejected for private farms)	- (DAR) depending on farm type

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Giannakas K. Schoney R. and Tzouvelekas V.	2000	Canada	debt -> TE (assumed)	+ (DAR)
Morrison Paul C.J et al	2000	New Zealand	debt -> TE (assumed)	- (DAR)

Noticeably, some papers decompose the overall asset to debt ratio into the corresponding short term intermediate and long term measures. In the three papers where intermediate DAR is analysed it is found to have a positive relationship with TE supporting the capital embodiment theory. Result about overall and short term DAR are mixed even if more negative signs are observed. A number of factors are likely to affect the observed evidence. First of all different methods are used to estimate the DAR-TE relationship either single stage stochastic frontier with simultaneous estimation of inefficiency model or two stage non parametric DEA estimates followed by OLS or tobit estimation of the inefficiency model. Different specification of both the SF or DEA model and inefficiency model select a number of alternative TE measures and covariates that can affect the estimate of the parameter of DAR. Ultimately the historical and institutional context in which the investigated farms operate is likely to impact on the DAR-TE relationship (Giannetti, 2003) , a noticeable example being the Davidova and Latruffe (2007) paper on a transition country and the Morrison Paul et al.(2000) one on policy reform in New Zealand.

3. Methods and data

a. farm performance measurement

We used farm accountancy data from RICA, the Italian version of FADN. The Italian sample for the years 2008-13 amounts to about 11 thousands farms/year for which both accountancy and structural data have been collected by the former National Institute of Agricultural Economics. Cereal Farms in the sample amount to about 11% of the total.

Two main approaches are usually carried out in order to measure firm efficiency: the parametric approach of a stochastic frontier and the non-parametric approach of Data Envelopment Analysis (DEA). The stochastic frontier method relies on the econometric estimation of a production function and the error term is composed by a white noise and an inefficiency term. DEA, instead, linearly program a deterministic efficient frontier through the best performing observations of the sample (Latruffe, 2012).

In this study we uses the DEA approach because of a main advantage over the stochastic frontier one: the former does not require any assumptions about the production function and the error term distribution. We calculated efficiency by carrying out an output-oriented DEA model for each year of the sample under the constraint of constant returns to scale, thus obtaining total technical efficiency (TTE) estimates. The DEA model include two outputs (the value in Euros of the production of cereals and other products) and four inputs (the value in Euros of capital and intermediate consumption, the total labour used in Annual Working Units and utilized land in hectares). Since DEA results are highly sensitive to the presence of outliers, we carried out a statistical method based on the algorithm proposed by Billor, Hadi and Velleman (2000) for the detection of multiple outliers in multivariate data.

b. Regression model

In order to investigate the impact of indebtedness on farm performance we run the following the regression equation:

$$TTE_{i,t} = a_0 + a_1 LEV_{i,t-1} + a_2 LEV_{i,t-1}^2 + a_3 LEV_{i,t-1} * YEAR_{i,t} + a_4 PROD_{i,t-1} + a_5 TANG_{i,t-1} + a_6 FAMLAB_{i,t-1} + a_7 SFP_{i,t-1} + a_8 Z_{i,t-1} + u_{i,t}$$

where *LEV* is the debt-asset-ratio, *PROD* is the value of total production, *TANG* is the ratio of tangible (excluding land) to total assets, *FAMLAB* is the share of family labour on total labour, *SFP* is the amount of the single farm payment, *Z* is a vector of control variables (the age and education of conductor, the share of rented utilized land, a regional dummy and a dummy equal to 1 for farms in disadvantaged areas) and *u* is a stochastic error term. a_2 is the coefficient of the interaction term between the legged indebtedness ratio and the year of observation. The quadratic specification is consistent with the possibility that the relationship between leverage and efficiency may not be monotonic.

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Since the dependent variable (is the inverse of the original output oriented efficiency scores estimated with DEA on a yearly basis) is a censored one, we run 4 cross sectional tobit models, one for each year from 2009 to 2013. The dependent variable To circumvent the potential endogeneity problem, all independent variables are lagged (see Margaritis, 2010; Nickell and Nicolitsas, 1999), this caused the loss of the first year of observations (2008).

4. Results

Model results shows some descriptives for the DEA scores (Table 1). The difference between the score and 1 represents the potential output expansion, so larger scores reveal greater inefficiency. Efficiency increases over the period and the coefficient of variation indicates the sample becomes more homogenous in terms of total efficiency. Anyway the results provide evidence that significant efficiency gains could be achieved by individual farms by improving production practices.

	Mean	Standard Deviation	Score of the least efficient farm	Coefficient of variation (%)	Share of farms with efficiency score of 1 (%)
2008	3.11	1.89	27.76	0.61	6.40
2009	2.73	1.37	13.78	0.50	6.07
2010	2.47	1.21	18.44	0.49	3.51
2011	2.32	1.29	19.53	0.56	4.57
2012	1.89	0.67	4.96	0.35	5.26
2013	2.11	0.75	6.15	0.36	2.65
Total	2.48	1.37	27.76	0.55	4.90

The results of the second stage tobit models are illustrated in table 2. A significant negative impact of the lagged debt to assets ratio is found only for years 2009 and 2010.

	pooled		2009		2010		2011		2012		2013	
L.leverage	-0.062	(0.072)	-0.314**	(0.148)	-0.710***	(0.271)	0.074	(0.187)	-0.176	(0.350)	-0.414	(0.293)
L.sq_lev	0.011	(0.048)	0.103	(0.071)	0.793*	(0.462)	-0.005	(0.145)	0.309	(0.548)	0.779	(0.497)
L.sales	0.041***	(0.004)	0.021***	(0.006)	0.026**	(0.010)	0.051***	(0.010)	0.047***	(0.011)	0.073***	(0.008)
L.tang	-0.112***	(0.017)	-0.074**	(0.033)	-0.005	(0.040)	-0.009	(0.038)	-0.116***	(0.042)	-0.085***	(0.031)
L.fam_lab	0.051**	(0.023)	-0.06	(0.041)	0.045	(0.053)	0.117**	(0.047)	0.082	(0.060)	0.141***	(0.051)
L.pua	-0.186***	(0.044)	-0.094	(0.076)	-0.296***	(0.114)	-0.226**	(0.102)	-0.533***	(0.139)	-0.275***	(0.081)
educ_conductor	0	(0.001)	0	(0.001)	0	(0.002)	-0.001	(0.001)	0	(0.002)	-0.003*	(0.001)
age_conductor	0	(0.000)	0	(0.001)	-0.002***	(0.001)	0.001	(0.001)	0	(0.001)	0	(0.001)
sau_rent	-0.063***	(0.012)	-0.019	(0.021)	-0.038	(0.027)	-0.049*	(0.028)	-0.104***	(0.030)	-0.050**	(0.022)
ZSVA	0.003	(0.012)	0.014	(0.020)	0.011	(0.029)	0.007	(0.025)	0.041	(0.030)	-0.027	(0.022)
region=1	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)	0	(.)
region=2	-0.136***	(0.012)	-0.116***	(0.021)	-0.105***	(0.031)	-0.144***	(0.028)	-0.136***	(0.032)	-0.128***	(0.024)
region=3	-0.092***	(0.014)	-0.080***	(0.024)	-0.107***	(0.037)	-0.108***	(0.030)	-0.073*	(0.038)	-0.028	(0.026)
Constant	0.188***	(0.067)	0.381***	(0.108)	0.397**	(0.169)	-0.069	(0.160)	0.273	(0.180)	-0.182	(0.135)
sigma												
Constant	0.172***		0.164***		0.158***		0.153***		0.169***		0.150***	
	(0.003)		(0.005)		(0.006)		(0.006)		(0.007)		(0.005)	
N	2051		565		334		365		337		450	
chi2	520.594		84.725		88.565		115.771		96.947		194.553	
p	0		0		0		0		0		0	
ll	578.638		196.771		126.562		147.372		82.333		190.119	
chi2	520.594		84.725		88.565		115.771		96.947		194.553	
* p<.1, ** p<.05, *** p<.01												

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The first year was characterized by a dramatic drop in the cereal prices (-30%) which was followed in 2010 by a timid increase by 6%. In 2011 prices were back to the pick of 2008 and stayed stable for the following years. Conversely input prices show a more regular rising trend from 2008 onward (Fig. 1).

Thus financial exposure seems to be a source of inefficiency in time of price turmoil when farms need to face adjustment hardship to cope with rapidly changing price scenarios. Therefore, we gauge that our empirical evidence support the adjustment theory by Morrison Paul et al. (2000).

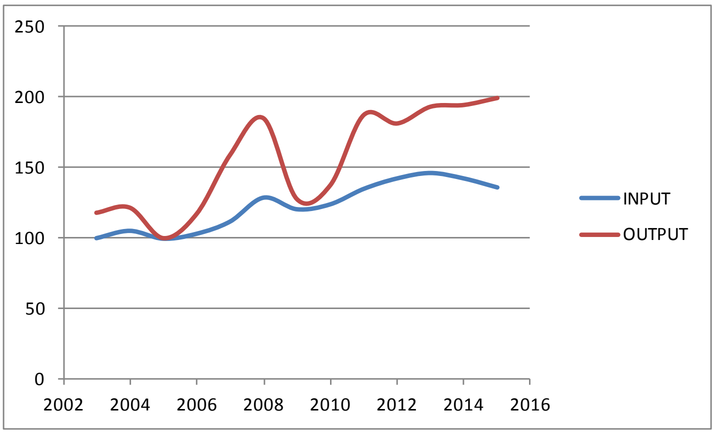

Fig. 1 Input and out prices

The results for other groups of variables show that large size as measured by total output is positively related to efficiency. This result is confirmed by many studies stating that technical efficiency and overall performance of farms are positively correlated with farm size (Mugera, 2011). Italian farms are small sized and have not reached an efficient size due to rigidities in the land market.

Conversely, single farm payment seems to negatively affect efficiency. The hypothesis that government payments reduce producer incentives to increase farming efficiency is also supported in other papers such as Giannakas et al (2001) and Hadley (1996) on arable crop farms.

Another variable which in all years but 2010-11 negatively impacts on efficiency is the ratio of tangible to total assets. One possible reason for the negative impact of the ratio is the overcapitalization of small farm which often are over mechanized.

Also farms with higher proportion of rented land are less efficient perhaps because of agency problems stemming from misalignment of farmer and landowner incentives as posited by Giannakis et al (2001) and Hadley (2006). The same agency issues can explain the positive impact on efficiency of the share of family labour observed in some years. Another possible explanation may be found in reduced farmers attitude toward long term investment as effect of land tenure.

Finally the regional dummies are always significant meaning that cereal farms in North Italy (mainly Padanian valley) are on average more efficient than in those located in central and southern regions. o

Conclusions

In this paper we implemented Data Envelopment Analysis (DEA) to measure farm output efficiency of Italian cereal farms and then we assess the relationship between farm capital structure and farm efficiency in the eve of the upsurge of cereal price volatility in years 2008-13. The empirical findings show that the relationship between farm efficiency and leverage is not significant for all years but 2009 and 2010. Interestingly, 2009 is the very year when cereal prices dropped by amost 30% after the upsurge of 2007-2008 this posing a significant stress on cereal farmers. Similarly to the policy induced price drop analysed by Morrison et al in New Zealand we found support for the adjustment theory as a possible explanation of the negative relationship between debt ratio and farm efficiency. To our knowledge this is the first paper that finds such support with respect to the 2008-2013 price volatility upsurge.

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