The impact of financial leverage on farms capacity to react in market shocks

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Abstract

Evidence in the literature supports that farmers' ability to choose the best available production technology is restricted when capital structure negatively influences farms' financial performance. Therefore, empirical evidence is sought to provide an understanding of the relationship between capital structure and technical efficiency of Italian farms in a period of five years (2008 – 2013). It is concluded that significant improvements could be achieved for most of the farms in the sample by improving production and management practices. Furthermore, results provide an empirical support of the adjustment theory by showing a negative impact of debt to asset ratio to technical efficiency.

Keywords: **[financial leverage, technical efficiency, capital structure, expenditure capacity, Italy]**

1 Introduction

Farm capital structure may have contrasting effects on farm efficiency as a strand of the farm efficiency literature has pointed out (Davidova and Latruffe, 2007). In particular, farmers' ability to choose the best available technology is restricted when capital structure negatively influences farm's financial performance (Mugera and Nyambane, 2015). External funding is used to cover both production costs and to finance investment plans (machinery, specialised equipment, and buildings) in order to enhance farm production performance (Lambert, David and Volodymyr, 2005). The debt is necessary to maintain or improve farm productivity and competitiveness by adopting technological innovation needed to increase farm efficiency (Featherstone, Allen, Gregory, Winter and Aslihan, 2005). At the same time, financial leverage may affect farm technical efficiency by influencing farm production decision. Allocative efficiency may be constrained by lower farm expenditure capacity (Färe, Grosskopf and Lee, 1990). 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 (Mugera and Nyambane, 2015). In addition, farm leverage may affect the farms capacity to react to market shocks adopting the needed strategic adjustments to maintain productivity, efficiency and competitiveness (Hughes, Richardson and Rister, 1985). The latter becomes relevant after the outbreak of the financial crisis in 2008 and it is the main focus of this study. According to Petrick and Kloss (2013) the recent economic and financial crisis addressed the following impacts due to the exposure of EU farmers to financial leverage: problems in the functionality of rural financial markets, reduction of farm incomes due to economic recession and lower demand for income elastic-food products. Moreover, in terms of public policy and support of the agricultural sector, the financial crisis could cause reduced public budget and spending cuts in agricultural and rural policies. According to Petrick and Kloss (2013) the crisis of the banking sector in European Union could potentially lead to a credit crunch for agricultural borrowers, by marring the way that rural financial markets are functioning. A number of papers is examining the impact of global financial crisis in relation to financial uncertainty, farm survival and the factors affecting the exit from the industry (Byrne, Spaliara and Tsoukas, 2016, Musso and Schiavo, 2008). Furthermore, the financial crisis caused surge in price volatility that affected European and world cereal markets starting from 2008 (Tadesse, Algieri, Kalkuhl and von Braun, 2014).

Italy was in the epicentre of the recent financial crisis of 2008. The economic recession and dwindling demand for income-elastic food products could potentially cause a reduction on farm incomes and could also cause a distortion in agricultural production due to limited access to credit for Italian farmers. Thus, the objective of this paper is to provide empirical evidence on the relationship between capital structure and technical efficiency for Italian cereal farms during the 2008 – 2013 period based on available RICA data for that period. Emphasis is given in the understanding of the relationship between the level of financial leverage for cereal farms and their production 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. According to Eurostat, the Italian cereal industry has been dramatically affected by the price crisis of 2008-2010 as the value of production fell by more than 30% in 2009 and fully recovered only in 2011. In terms of comparison, the overall agricultural production decreased only by 8% in the same period. Noticeably, credit to agriculture became more and more important as the price crisis unfolded. In 2014 the amount of bank loans to farms was about 20% higher than in 2008 as illustrated by the data from Bank of Italy in. In the same years, the share of short term loans rose from 56 to 70% of the total amount, an indication that farmers resorted to loan financing mainly to deal with liquidity problems and economic stresses. The aim is to provide a first insight on the evolution of the Italian cereal farms debt-technical efficiency relationship in periods where high price volatility has been observed.

2 Farm performance and capital structure

Several theoretical explanations, often predicting contrasting evidence, have been put forward to explain the existence, if any, of a direct relationship between measures of indebtedness such as the leverage[1] or Debt to Asset Ratio (DAR) and Technical Efficiency (TE). According to Zhengfei and Lansink (2006) financial indicators may not fully reveal the relationship between farm performance and managerial activities to improve performance when the effect of financial leverage is taken into consideration. Instead, Zhengfei and Lansink (2006) suggest that a measure of TE which is independent of market prices is more appropriate.

The Fisher separation theorem states that, under perfectly functioning financial markets, financial and investment decisions are independent. As a consequence, TE which depends on investment decisions should not be related to the way investments are financed (Lambert, David and Volodymyr, 2005). However, in the context of agricultural investment, according to O'Toole, Newman and Hennessy (2014), the financing constraints affect farmers' investment decisions through an excess reliance on internal farm funds for investment and farmer's investment strategies are based on the business fundamentals such as profitability.

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

The free cash flow model (Jensen and Meckling, 1976) 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).

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

The agency cost model (Jensen and Meckling, 1976) states 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 TE of the affected farms in comparison with less indebted ones.

The two approaches so far mentioned both hypothesise a causal relationship (even if with opposite direction) from indebtedness 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 loans are granted mainly on the availability of adequate collaterals, as it is the case in Italy, the hypothesis is less relevant (Davidova and Latruffe, 2007).

Other hypothesis on the indebtedness and TE relationship are specific to the farm sector: the capital embodiment theory and the adjustment cost theory. Chavas and Aliber (1993) 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 Paul, Johnston and Frengley (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.

Hence, 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 it concerns the sign of the relationship while, endogeneity of debt is mainly assumed and not tested but for the case of Davidova and Latruffe (2007), as it is shown in Table 1.

Noticeably, a group of researchers decompose the overall asset to debt ratio into the corresponding short term intermediate and long term measures. In Lambert, David and Volodymyr (2005), Mugera and Nyambane (2015) and Chavas and Aliber (1993) where intermediate DAR is analysed it is found to have a positive relationship with TE supporting the capital embodiment theory. Results 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, 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. Moreover, different specification of both the SFA or DEA model and inefficiency model select several 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), noticeable examples being the Davidova and Latruffe (2007) and the Paul, Johnston and Frengley (2000).

This study will employ non-parametric techniques in order to derive TE estimates for a sample of Italian cereal farms to explore in depth the relationship amongst the financial exposure of the sector and the capacity to utilise an efficient and effective production technology. The objective is to increase understanding in regards to financial capital structure, and to provide a new insight into the relationship between DAR-TE for the Italian cereal sector.

3 Methods and data

Farm accountancy data for the empirical model was derived from RICA, the Italian version of FADN. The Italian sample for the years 2008 – 2013 amounts to about 11 thousand farms per year for which both accountancy and structural data have been collected by the former National Institute of Agricultural Economics. Cereal Farms amount to about 11% of the total sampled farms a figure in line with the weight of cereals production over total Italian agricultural output[2]. With over 4 billion Euro of output Italy in 2014 was the third cereal producer in the European Union after France and Germany and just above UK and Poland.

Efficiency was estimated by carrying out an input-oriented sub-vector DEA model for each year of the sample and for each Italian macro-region[3] under the constraint of constant returns to scale, thus obtaining total technical efficiency (TTE) estimates. The sub-vector (SBV) DEA model has been used to account for the non-discretionary input of the CAP pillar one subsidies. It is assumed that farmers have no control over the amount of money that they receive and hence it is an input that they cannot directly influence within the production function. Therefore, a non-discretionary or SBV DEA model is used to evaluate input use efficiency estimates for cereal farms. The DEA model include two outputs (the value in Euros of the production of cereals and other products) and five inputs: the value in Euros of fixed capital costs (depreciation and passive rents) and intermediate consumption, the total labour used per farm in Annual Working Units, the utilized agricultural area (UAA) in hectares and the Common Agricultural Policy 1st pillar subsidies received per farm. 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.

Table 2 reports summary statistics for the variables included in the DEA model. The average value of Pillar I subsidies remains nearly constant over the period, as well as the amount of utilized agricultural area (UAA) and labour (man units). However, the value of fixed capital costs slightly increases over the period under consideration, while the value of intermediate consumption remains constant over 2008-2010 and increases in 2011 and 2012 (22% increase) reaching its peak in 2013 (38,000 €).

To formalise the above let us assume that we observe a set of n farms and each farm $i = \{1,..,n\}$ has a set of inputs and outputs representing multiple performance measures. Considering then that each farm i uses J $(j = 1,\cdots,J)$ inputs, x_j to produce S outputs y_r $(r = 1,\cdots,S)$. The general form of an input oriented DEA linear programming (CNV DEA model) with all inputs variable is as follows:

$$\begin{aligned} & min_{\theta,\lambda^i}\ \theta'_{CNV} \\ & s.t. \quad \theta\, x'_{ji} \geq \textstyle\sum_{i=1}^{n} \lambda^i x_{ji} \qquad (i) \\ & \qquad\ \ y'_{ri} \leq \textstyle\sum_{i=1}^{n} \lambda^i y_{ri} \qquad (ii) \\ & \qquad\ \ \lambda^i \geq 0 \qquad (iii) \end{aligned} \tag{1}$$

[2] The mere share of cereals over total agricultural output does not fully account for the relevance of the industry in Italy. Indeed, cereals and in particular durum wheat are the raw material for food products such as pasta for which Italy is famous around the world.

[3] Italian macroregions are defined as NUTS1 regions (North West, North East, Centre, South, Islands). To obtain 4 similarly sized sub samples we aggregated South Italy with the Islands resulting in 4 macroregions..

Where, θ'_{CNV} , is a scalar, representing the efficiency score for each of the n farms estimated by the CNV DEA model. The estimate will satisfy the restriction $\theta_i \leq 1$ with the value $\theta_i = 1$ indicating an efficient farm. This is because the ratio is formed relative to the Euclidean distance from the origin over the production possibility set. Also, in the above formulation we consider that there is a set of discretionary or variable inputs DI, $DI \subset \{1, \cdots, j\}$ and a set of non-discretionary inputs NDI, $NDI = \{1, \cdots, F\} \setminus DI = \{h \in \{1, \cdots J\} \big| h \notin DI\}$ that cannot be adjusted or are held fixed at least in the short run.

The combination of the DI and NDI variables defines therefore the technology set P_{SBV}:

$$\mathrm{P_{SBV}} = \left\{ \left(\mathrm{x_{DIji}}, \mathrm{x_{NDIji}}, \mathrm{y_{ri}} \right) \middle| \mathrm{x_{DIji}} \text{ and } \mathrm{x_{NDIji}} \text{ can produce } \mathrm{y_{ri}} \right\} \qquad (2)$$

As suggested by Bogetoft and Otto (2010) in cases where DI and NDI variables exist, a traditional and popular variation of the Farrell (1957) procedure is used to solve the linear DEA programme with respect to the largest proportional reduction in the DI variables alone.

$$\theta\left((x_{DIji}, x_{NDIji}, y_{ri}); P \right) = min_{\theta}\{\theta \big| (\theta x_{DIji}, x_{NDIji}, y_{ri}) \in P\} \qquad (3)$$

The linear DEA programme can therefore be modified as follows where only the DI variables are reduced. Thus, the input use DEA efficiency score when accounting pillar one subsidy variations for observation x', θ', is estimated by the following linear programming (LP) problem:

$$\begin{aligned} & min_{\theta,\lambda^i}\ \theta'_{SBV} \\ & s.t. \quad \theta x'_{DIji} \geq \textstyle\sum_{i=1}^{n} \lambda^i x_{DIji} \qquad j \in DI \quad (i) \\ & \qquad x'_{NDIji} \geq \textstyle\sum_{i=1}^{n} \lambda^i x_{NDIji} \qquad j \in NDI \quad (ii) \\ & \qquad y'_{ri} \leq \textstyle\sum_{i=1}^{n} \lambda^i y_{ri} \qquad (iii) \\ & \lambda^i \geq 0 \qquad (iv) \end{aligned} \qquad (4)$$

Where, x_{DIji} is the j^{th}discretionary input for farm i , x_{NDIji} is the j^{th} non-discretionary input for farm i and y_{ri} is the r^{th} output for farm i, $i = (1, \cdots n)$, $j = (1, \cdots m)$ and $r = (1, \cdots s)$. The optimal value θ_{SBV} represents the SBV efficiency score for each farm and its values lie between 0 and 1. This efficiency score indicates the degree to which a farm can reduce the use of its discretionary inputs without decreasing the level of outputs regarding the best performers or benchmarking farms in the sample. The first two constraints limit the proportional decrease in both discretionary (equation - 5(i)) and non-discretionary (equation - 5(ii)) inputs, when θ_{SBV} is minimised in relation to the input use achieved by the best observed technology. The third constraint ensures that the output generated by the i^{th} farm is less than that on the frontier. All three constraints ensure that the optimal solution belongs to the production possibility set. The final constraint expressed by the equation 5(iv), called also the convexity constraint, ensures the CRS assumption of the DEA SBV model (Cooper, Seiford L. M and Tone K., 2006).

Furthermore, to investigate the impact of indebtedness on farm performance we run the following regression equation: $TTE_{i,t} = a_0 + a_1 LEV_{i,t-1} \ + \sum_{j=2}^{15} a_j Z_{i,t} + u_{i,t}$

where *LEV* is the debt-asset-ratio, *Z* is a vector of farm control variables described below and *u* is a stochastic error term.

Since the dependent variable (the SBV CRS efficiency scores) is a fractional one, defined over the close interval [0,1] we run four cross sectional OLS models for each year, after having transformed the dependent variable via the cumulative logit function (McDonald, 2009). Efficiency scores which take value of 1 (i.e. are on the frontier) have been converted to 0.9999 to avoid 0s in the data. To circumvent the potential endogeneity problem, the leverage variable is lagged (Margaritis and Psillaki, 2010, Nickell and Nicolitsas, 1999), this caused the loss of the first year of observations

(2008). Table 3 reports summary statistics of leverage and control variables included in the regression model. Apart from regional dummies the variables consider farmer and farm characteristics such as age, sex, year in education as well as size (measured by standard output), share of rented land, share of family labour, share of tangible assets over total assets (net of real estate capital). In addition, a dummy for farms located in municipalities classified as less favoured areas was used.

The (lagged) level of indebtedness or leverage is the main variable of interest. Its value for cereal farms is very low, with small changes over the period 2009-2014. The ratio of tangible to total assets shows a decline over the period 2009-2014, revealing a relative decrease in long-term investments. The standard output slightly increases in 2010 (despite low cereal prices), it remains quite stable over the years 2011-2013 and increases in 2014.

4 Results and discussion

A summary of the DEA SBV model results are presented in Table 4. The figures represent the potential equiproportional input reduction keeping constant the output, so smaller scores reveal greater inefficiency. An increase in the average efficiency score is observed in 2011 and is then maintained for the rest of the period under consideration. In addition, results indicate that efficiency is quite dispersed especially in the harvest periods of 2009 and 2010. These results suggest the need for improvements in production and management practices for the majority of the farms in the sample. In particular, it could be suggested that 36% equiproportional reduction in the use of inputs is required for 2009, 32% for 2010, 27% for 2011, 26% for 2012 and 2014 and a 28% for 2013.

The results of the second stage regression models are illustrated in Table 5. The dependent variable is a logit transformation of the CRS efficiency scores which is regressed on the lagged DAR and other control variables. Noticeably, the parameter of the lagged DAR is not always significant. A significant (at 10% level) negative impact of the lagged DAR is found only for the year 2010. As this finding is relevant, especially when the link of the impact of DAR on efficiency to the price crisis of 2009-2010 is considered, we tested the robustness of parameter estimates carrying out also "canonical" OLS (without the logit transformation of the dependent variable) and the quasi maximum likelihood estimator proposed by Papke and Wooldridge (1993) for handling proportions data. Both additional estimates are consistent with a highly significant impact of indebtedness for 2010 (at the 1% level) even if a less significant negative impact of DAR is found in this case also for year 2014 .

The negative impact of DAR in 2010 may be viewed as an empirical support of the adjustment theory posited by Paul, Johnston and Frengley (2000) by analysing the policy induced price drop occurred in New Zealand in the late '80s. Indeed, the years 2009-2010 were characterized by a dramatic drop in the cereal prices (-30% in 2009) which was followed in 2010 by a timid increase by 6%, still far below the 2007-2008 level. In 2011 prices were back to the peak of 2008 and stayed stable for the following years. Conversely input prices showed a more regular rising trend from 2008 onward (Figure 2). Thus, years 2009 and 2010 were particularly unfavourable for the cereal industry because of both the drop-in output prices and the adverse terms of trade[4]. 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. The drop in cereal prices increases the financial constraints faced by indebted farms, thus reducing their ability to cope with higher financial stress and in turn decreasing their efficiency.

[4] It is worth noticing that an adverse term of trade arises again in 2014 when the output price index is still falling from its 2011 peak whereas the input price index reaches a peak (see figure 2)

Furthermore, size, measured by standard output, is statistically significant for the years 2010, 2011, 2012, 2013 and 2014 and it has a positive impact on efficiency. This is also confirmed by studies stating that technical efficiency and overall performance of farms are positively correlated with farm size (Mugera and Langemeier, 2011, Gadanakis, Bennett, Park and Areal, 2015). This, is an important finding with further implications to the Italian cereal sector. The results suggest that economies of scale will need to be developed in order to improve productivity and the technical efficiency of farms. Currently, Italian farms are small sized and have not reached an efficient size due to rigidities in the land market.

Another variable which in all years 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 Italian small farms 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 Giannakas, Schoney and Tzouvelekas (2001) and Hadley (2006). Another possible explanation may be found in reduced farmers' attitude towards long term investment as effect of land tenure. The coefficient referring to less favoured areas is significant and negative only in 2011. Finally, the coefficients of regional dummies reveal that cereal farms in North Italy (mainly North-western regions) are on average more efficient than in those located in central and southern regions. The gender of farm conductor does not impact efficiency, while the years of education of conductor, a proxy for human capital, is positive and significant only for 2010, while the age dummy of conductor was not statistically significant with an exception of 2014 where it is statistically significant and has also a negative effect.

5 Conclusions

In this paper, a SBV CRS DEA model was utilised to measure farm output efficiency of Italian cereal farms and to 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 statistically significant for all years but 2010. Interestingly, 2009 is the very year when cereal prices dropped by almost 30% after the upsurge of 2007-2008 thus posing a significant stress on cereal farmers reflected to the technical efficiency of 2010. Similarly, to the policy induced price drop analysed by Paul, Johnston and Frengley (2000) in New Zealand, results 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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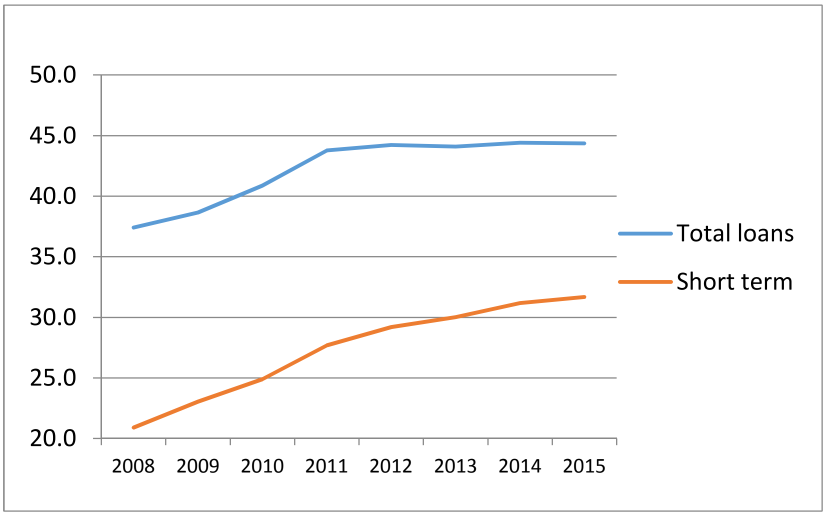
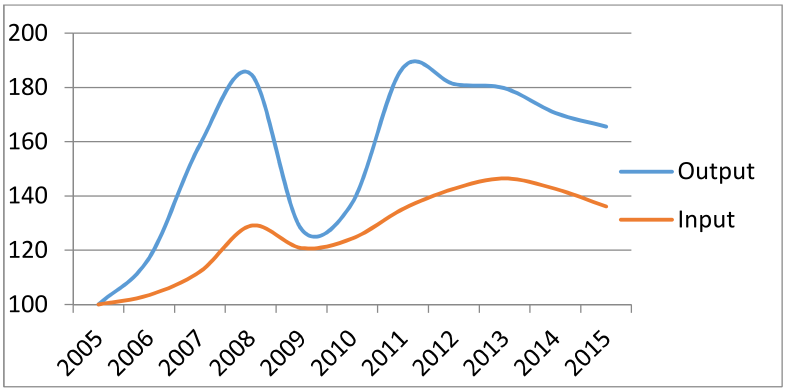


Source: Bank of Italy (2016)

Figure 1: Loans to Italian farms: Millions of €



Source: EUROSTAT

Figure 2: Cereals output and agricultural input price indexes Italy

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

Authors	**Country**	**Endogeneity of debt**	**Sign of relationship**
Lambert, David and Volodymyr (2005)	USA	(assumed)	- (short term DAR) + (intermediate DAR)
Mugera and Nyambane (2015)	Australia	(assumed)	+ (short term DAR) ns (long term DAR)
Chavas and Aliber (1993)	USA	(assumed)	ns (short term DAR) + (intermediate DAR) + (long term DAR)
Hadley (2006)	UK	(assumed)	- (DAR)
Davidova and Latruffe (2007)	Czech Rep.	(tested and rejected for private farms)	- (DAR) depending on farm type
Giannakas, Schoney and Tzouvelekas (2001)	Canada	(assumed)	+ (DAR)
Paul, Johnston and Frengley (2000)	New Zealand	(assumed)	- (DAR)

Table 2: Descriptive statistics of outputs and inputs used in the DEA sub-vector model

	2008		2009		2010									
	Mean	*S.D.*	Mean	*S.D.*	Mean	*S.D.*	Mean	*S.D.*	Mean	*S.D.*	Mean	*S.D.*	Mean	*S.D.*
Crop Output (000€)	46	*73*	42	*74*	51	*71*	58	*78*	60	*75*	56	*76*	58	*86*
Other Output (000€)	12	*21*	11	*21*	7	*13*	8	*15*	6	*11*	7	*13*	7	*14*
Pillar I subsidies (000€)	19	*29*	20	*29*	20	*32*	21	*31*	20	*29*	21	*32*	21	*37*
Labour (man units)	11	*8*	11	*8*	11	*7*	12	*8*	12	*8*	12	*8*	12	*8*
UAA Ha	44	*54*	45	*52*	43	*49*	44	*50*	43	*46*	43	*48*	43	*48*
Intermediate consumption (000€)	32	*39*	31	*38*	31	*43*	37	*47*	38	*46*	38	*48*	38	*50*
Fixed capital costs (000€)	7	*12*	8	*11*	8	*13*	7	*12*	8	*14*	8	*13*	8	*13*

Table 3: Summary statistics of the control variables included in the regression model

	2009		2010		2011		2012		2013		2014	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Cum. Logit transf. of eff. scores	1.44	2.83	1.64	2.79	1.89	2.74	2.15	2.97	1.90	2.84	2.01	2.82
Lagged leverage	0.02	0.10	0.02	0.09	0.02	0.12	0.01	0.09	0.01	0.08	0.02	0.11
Share tangible assets	0.79	0.24	0.73	0.27	0.73	0.26	0.69	0.27	0.67	0.28	0.64	0.29
Share farm labour	0.94	0.17	0.95	0.16	0.95	0.16	0.95	0.16	0.95	0.14	0.95	0.14
Education in years	8.13	3.78	8.72	3.53	8.69	3.65	8.75	3.53	8.75	3.39	9.07	3.34
Age	57.92	14.18	57.83	14.31	58.75	13.89	59.23	13.95	59.55	13.90	58.60	13.41
Share rented land	0.37	0.42	0.39	0.42	0.35	0.41	0.37	0.41	0.38	0.42	0.42	0.41
Standard Output (000€)	54.55	66.13	60.62	77.83	58.29	82.35	58.32	75.45	55.05	70.84	67.17	82.84
Young	11%		11%		8%		7%		7%		7%	
Elder	31%		32%		34%		34%		35%		33%	
Female	16%		16%		17%		17%		16%		16%	
Farm in total LFA	27%		31%		31%		30%		32%		28%	
Region NW	26%		32%		23%		25%		23%		29%	
Region NE	23%		21%		26%		24%		26%		28%	
Region Central	24%		22%		22%		24%		25%		20%	
Region South	23%		23%		27%		25%		24%		22%	
Region Islands	4%		2%		2%		2%		2%		2%	

Note: Standard output calculated according to Regulation (EC) No 1242/2008. Region NW includes Piedmont, Lombardy, Liguria and Aosta Valley; region NE includes Veneto, Emilia Romagna, Trentino Sud Tirol, Friuli Veneza Giulia and Emilia Romagna; Region Central Includes Tuscany, Umbria, Marche and Lazio, South includes Abruzzi, Molise Apulia, Campania, Basilicata, Calabria; Island includes Sicily and Sardinia.

Table 4: Summary table of efficiency scores derived from an input oriented CRS DEA model

Technical Efficiency Distribution	2009 No of Farms	2010 No of Farms	2011 No of Farms	2012 No of Farms	2013 No of Farms	2014 No of Farms
eff<0.5	291	157	104	65	106	56
0.5≤eff<0.6	154	119	157	127	141	95
0.6≤eff<0.7	169	136	162	208	180	121
0.7≤eff<0.8	133	104	185	173	179	143
0.8≤eff<0.9	93	93	155	123	114	100
0.9≤eff<1	52	53	85	76	71	64
Efficiency=1	105	79	105	125	108	78
% of farms on the frontier	11%	11%	11%	14%	12%	12%
Mean Efficiency	0.64	0.68	0.73	0.74	0.72	0.74
SD Efficiency	0.21	0.20	0.18	0.17	0.18	0.18

Note: outliers and observations with either negative outputs or negative inputs dropped

Table 5: Output of the second stage regression analysis

	2009		2010		2011		2012		2013		2014	
	Coef	***S.E.***	**Coef**	***S.E.***	**Coef**	***S.E.***	**Coef**	***S.E.***	**Coef**	***S.E.***	**Coef**	***S.E.***
Lagged Leverage	0.33	*0.89*	-1.49*	*0.77*	0.03	*0.37*	0.54	*0.96*	-0.23	*0.53*	-0.36	*0.74*
Standard output	0.07	*0.1*	0.40***	*0.12*	0.50***	*0.12*	0.46***	*0.13*	0.1	*0.11*	0.33**	*0.17*
Share tangible assets	-3.16***	*0.5*	-2.93***	*0.55*	-2.40***	*0.45*	-2.98***	*0.51*	-2.83***	*0.48*	-2.34***	*0.55*
Share farm labour	-1.04*	*0.61*	-0.54	*0.72*	0.09	*0.63*	-0.4	*0.75*	0.33	*0.69*	-0.96	*0.96*
Education in years	0.22	*0.15*	0.03	*0.22*	-0.16	*0.2*	0	*0.19*	0.26	*0.21*	-0.21	*0.29*
Young	0.33	*0.31*	-0.06	*0.3*	0.05	*0.31*	-0.15	*0.39*	-0.01	*0.38*	0.41	*0.45*
Elder	0.08	*0.21*	0.11	*0.24*	0.26	*0.22*	-0.12	*0.24*	-0.11	*0.22*	-0.46*	*0.25*
Female	-0.36	*0.25*	-0.45*	*0.26*	0.24	*0.25*	0.05	*0.27*	0.16	*0.27*	-0.07	*0.29*
Share rented land	-0.65**	*0.28*	-0.95***	*0.37*	-1.02***	*0.3*	-1.03***	*0.34*	-0.71**	*0.33*	-0.98**	*0.39*
Farm in total LFA	-0.09	*0.31*	0.34	*0.34*	-0.82***	*0.29*	-0.28	*0.31*	-0.39	*0.29*	-0.28	*0.31*
Region NE	1.56***	*0.25*	0.83***	*0.28*	0.60**	*0.25*	1.10***	*0.28*	0.70***	*0.27*	1.11***	*0.32*
Region Central	0.95***	*0.3*	0.58*	*0.33*	0.37	*0.32*	0.78**	*0.36*	1.07***	*0.35*	0.55	*0.37*
Region South	0.13	*0.38*	-0.93**	*0.39*	0.98***	*0.37*	0.67*	*0.36*	0.66**	*0.33*	0.89**	*0.41*
Region Islands	0.6	*0.58*	-0.7	*0.92*	0.08	*0.54*	0.69	*0.72*	0.11	*0.53*	0.06	*0.7*
Constant	3.43**	*1.54*	0.36	*1.65*	-1.25	*1.8*	-0.22	*1.96*	1.71	*1.75*	1.53	*2.52*
N	997		741		953		897		899		657	
R^2	0.08		0.11		0.07		0.06		0.05		0.05	

Note: Standard output calculated according to Regulation (EC) No 1242/2008. Region NW includes Piedmont, Lombardy, Liguria and Aosta Valley; region NE includes Veneto, Emilia Romagna, Trentino Sud Tirol, Friuli Veneza Giulia and Emilia Romagna; Region Central Includes Tuscany, Umbria, Marche and Lazio, South includes Abruzzi, Molise Apulia, Campania, Basilicata, Calabria; Island includes Sicily and Sardinia.