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Technical efficiency and technology adoption: a study of organic farming in the French dairy sector

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Abstract

Using original survey data from France we study the importance of technical efficiency as a potential determinant of farm conversion to organic farming in the dairy sector. We run a two-stage analysis. In the first stage we calculate technical efficiency of farms when they were conventional (including organic farms before they convert) as well as technical efficiency change indices, using Data Envelopment Analysis and correcting for sample bias with Simar and Wilson's bootstrapping procedure. In the second stage, we estimate a Probit model to explain the decision of farmers to convert to organic farming. The model is estimated on a sample of 209 farmers. We find that farmers who switched to organic farming were more technically efficient (before conversion) than farmers who remained conventional, but they had experienced a slowdown in technical efficiency (also before conversion).

Keywords: *technical efficiency; farms; conversion to organic farming; France*

Introduction

Environment-friendly practices in agriculture are now widely promoted by governments in developed countries. In this context organic farming is an appealing alternative to conventional farming. In order to target the promotion of organic farming, policy-makers are interested in the profile of the farms that are the most likely to convert from conventional farming to organic farming. Therefore, empirical studies investigating the determinants of farm conversion to organic farming are of particular interest. The literature on this issue is particularly rich (e.g. Gardebroek 2003; Genius et al. 2006; Knowler and Bradshaw 2007; Läpple 2010; Tiffin and Balcombe 2011) and highlights internal factors (e.g. farmers' education, farm size). However, except for Kumbhakar et al. (2009) and Latruffe and Nauges (2014), the

role of technical efficiency as a potential determinant of farm conversion to organic agriculture has not been studied.

Technical efficiency (TE) achieved by farms under conventional agriculture may determine whether they convert to organic agriculture or remain in conventional agriculture. However, it is difficult to draw hypotheses on the direction of the link. The link may be positive in the sense that more efficient farms may be more capable of adopting new complex technologies and therefore may be more likely to adopt organic technology. The link may be negative, as choosing to produce for the niche organic market may be a survival strategy for technically inefficient conventional farms that cannot compete with highly technically efficient conventional farms.

The paper investigates empirically this issue of whether TE is a driver of the decision to apply organic agriculture on a farm, for the specific example of dairy farms in France. We consider the level of TE in the year before the decision to convert (or not) to organic farming is taken, as well as the change in TE between the last two years preceding the conversion.

Data and methodology

The data used are farm-level data for the period 2006-2010 for 307 dairy farms from North West France. Among those 307 farms, 233 farms remained in conventional agriculture for the whole period studied and 74 farms switched to organic agriculture at some point during the period. In what follows, and for ensuring homogeneity in the environmental and economic conditions, we analyze the conversion decision in the years 2009 and 2010. We thus keep the farmers who converted their farm to organic farming in 2009 or in 2010, along with all farmers who remained conventional over the same period. In order to keep only one observation per farm, we randomly select the year of observation (2009 or 2010) for the conventional farms. The final sample used for the analysis covers 209 farms, including 180 conventional farms and 29 organic farms.

Our research question is investigated with a two-stage approach. In the first stage we calculate TE of all farms when they were conventional (including organic farms before their conversion). In a second stage we estimate a Probit model representing the switch, or not, to organic agriculture. The main explanatory variables of interest in this model are the level of TE and the change in TE in the year preceding the decision (to convert or not).

In the first stage, TE is calculated with Data Envelopment Analysis (DEA), correcting for sample bias with Simar and Wilson's bootstrapping procedure (1998, 2000). In addition, TE change (TEC) is calculated with Malmquist indices corrected for bias (Simar and Wilson 1999). Yearly DEA frontiers are constructed under the assumption of constant returns to scale. The DEA model is output-oriented and includes two outputs and four inputs. The two outputs are the quantity of milk produced (in liters) and the value of all farm outputs other than milk (in Euros). The four inputs are the agricultural land area (in hectares), the farm labor (in terms of annual full time equivalents), the value of farm capital (in Euros), and the cost of intermediate consumption (seeds, fertilizers, animal feed, veterinary cost) (in Euros). All values were deflated with the consumption price index with base 2006.

In the second stage, the binary dependent variable of the Probit model takes the value 1 if the farmer took the decision to switch to organic farming in 2009 or in 2010, and

0 otherwise. Several explanatory variables are included in the model, based on the existing literature on the determinants of conversion to organic farming: average milk produced per cow (MILKCOW); gross operating profit per cow (GOP); number of cows per hectare of pasture area (COWHA); debt ratio (DEBT); whether the farmer was a member of a farmer union (UNION); whether the farmer had contracted agri-environmental schemes (AES); and whether a shared machinery cooperative or contract work services for organic production were available (SHARED). These variables are all measured the year before the decision to convert (or not) was taken. Our model also includes variables capturing farmers' opinion about the impact of agricultural activities on the environment and on farmers' health. More precisely we consider a dummy variable that takes the value 1 if the farmer thinks that some agricultural production methods can be environmentally damaging (ENV) and another dummy variable taking the value 1 if the farmer considers that there is a high health risk associated with the use of pesticides (HEALTH). We also control for heterogeneity in soil characteristics using a dummy variable that takes the value 1 if part of the cultivated area on the farm is in a wetland (WETL), and the soil pH (PH). Finally we control for the year of observation (2009 or 2010). In addition, as explained above, the TE score and the index of TEC are included as explanatory variables. For farms remaining conventional during the whole period, we use the TE score and the TEC index calculated for the year preceding the year of observation. For farms switching to organic farming in 2009 or 2010, TE and TEC are measured in the year before the year of conversion to organic agriculture.

Table 1 presents some descriptive statistics of the main variables of interest, separately for the farmers who remained conventional and for farmers who switched to organic farming. A test of mean equality was performed for each variable and the outcome of this test is shown in the last column. Farmers who decided to convert to organic farming were characterized, before conversion, by a higher level of TE, a lower production of milk per cow, a higher gross operating profit per cow, and a lower stocking rate (number of cows per hectare). Also, union membership, availability of a shared machinery cooperative, as well as sensitivity to environmental and health issues, are more common in the group of farmers who converted to organic farming.

Table 1. Descriptive statistics on the main variables of interest

	Farmers who remained conventional	Farmers who switched to organic farming	Test of mean equality
TE (in level)	0.71	0.78	***
TE change (TEC)	1.08	1.01	n.s.
Average milk produced per cow (MILKCOW); <i>in 1,000 liters</i>	6.95	6.07	***
Gross operating profit per cow (GOP); <i>in 1,000 Euros</i>	0.74	0.89	**
Number of cows per hectare of pasture area (COWHA)	3.71	1.66	***
Debt ratio (DEBT); <i>in %</i>	52.06	54.28	n.s.
The farmer is a member of a farmer union (UNION); 0/1	0.37	0.59	**
The farmer has contracted agri-environmental schemes (AES); 0/1	0.21	0.45	***
A shared machinery cooperative or contract work services for organic production are available (SHARED); 0/1	0.32	0.66	***
The farmer thinks that some agricultural production methods can be environmentally damaging (ENV); 0/1	0.54	0.93	***
The farmer considers that there is a high health risk associated with the use of pesticides (HEALTH); 0/1	0.51	0.93	***
Part of the cultivated area on the farm is in a wetland (WETL); 0/1	0.67	0.62	n.s.
Soil pH (PH); <i>ph unit</i>	6.30	6.17	n.s.
Number of farms	180	29	

Note: all variables except the last four are measured the year before the decision to convert (or not) to organic farming was taken. Test of mean equality outcomes reads as follows: *, **, and *** indicate that means in the two groups are statistically different at the 10, 5, and 1% level, respectively; n.s. is for not significant.

Results

Estimation results (including marginal effects averaged over all observations) are shown in Table 2. The overall fit of the model is good since the pseudo-R² is 0.68 and the model predicts conversion (and non-conversion) correctly in 94% of the cases. Our results show that the likelihood of conversion to organic farming is driven by (past) TE. Farmers who switched to organic farming were characterized by a higher TE in conventional farming. A higher gross operating profit per cow is a positive driver of conversion. These two findings suggest that highly performing farms are more likely to convert to organic farming. We also find that farms that converted experienced a slowdown in TE the year before conversion. One possible explanation might be that they had already taken the decision to convert to organic farming and had started adjusting their practices when they were still in conventional farming.

This would be confirmed by the findings that a lower number of cows per hectare of pasture area as well as a lower production of milk per cow increase the likelihood of converting to organic farming. Availability of shared machinery through a cooperative positively influences conversion. Finally our results show that farmer's opinion about health hazards related to pesticide use and environmental concern do influence the decision to convert to organic farming.

Table 2. Probit estimation results (209 observations)

	Coef.	Std. Err.	P>z	Average marginal effect ^a
Constant	485.348	967.205	0.500	
TE (in level)	10.434	3.360	0.002	0.732
TE change (TEC)	-7.311	2.680	0.006	-0.513
MILKCOW	-0.729	0.224	0.001	-0.051
GOP	1.993	0.658	0.002	0.140
COWHA	-0.768	0.235	0.001	-0.054
DEBT	0.003	0.010	0.734	0.000
UNION	0.692	0.462	0.134	0.004
AES	-0.032	0.526	0.951	0.000
SHARED	1.874	0.541	0.001	0.048
ENV	1.963	0.733	0.007	0.020
HEALTH	1.053	0.545	0.053	0.007
WETL	0.610	0.518	0.239	0.003
PH	-3.155	1.299	0.015	-0.221
Year 2010	-0.232	0.481	0.629	-0.016
Pseudo R2	0.680			
LR chi2(14)	114.40	0.0000		
Percentage of good predictions	94%			

^a Average of marginal effects computed over all observations.

Conclusions

Using original survey data for a sample of French dairy farmers, we assess the role of (past) technical efficiency in the decision to adopt organic farming. More precisely we measure technical efficiency of all conventional farms, including organic farms before they convert, using DEA and correcting for sample bias. Our results show that technical efficiency is a strong determinant of conversion, and that not only the level of technical efficiency matters but also the change in technical efficiency. We find that a higher technical efficiency increases the likelihood of conversion but, conditional on this level, farmers who experienced a slowdown in technical efficiency are more likely to switch to organic farming. We expect that the slowdown in technical efficiency is a consequence of the fact that farmers had taken the decision to switch to organic farming a few years before actual conversion, and hence had already started to adjust their practices.

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References

Gardebroek C. (2003) Farm-specific factors affecting the choice between conventional and organic dairy farming, *Tijdschrift voor Sociaal wetenschappelijk onderzoek van de Landbouw* 18(3): 140-148.

Genius M., C. Pantzios, V. Tzouvelekas (2006) Information acquisition and adoption of organic farming practices, *Journal of Agricultural and Resource Economics* 31(1): 93-113.

Knowler D., B. Bradshaw (2007) Farmer’s adoption of conservation agriculture: A review and synthesis of recent research, *Food Policy* 32: 25-48.

Kumbhakar, S., E. Tsionas, T. Sipiläinen (2009) Joint estimation of technology choice and technical efficiency: an application to organic and conventional dairy farming, *Journal of Productivity Analysis* 31: 151-161.

Läpple D. (2010) Adoption and abandonment of organic farming: An empirical investigation of the Irish drystock sector, *Journal of Agricultural Economics* 61(3): 697-714.

Latruffe, L., C. Nauges (2014) Technical efficiency and conversion to organic farming: the case of France, *European Review of Agricultural Economics* 41(2): 227-253.

Tiffin R., K. Balcombe (2011) The determinants of technology adoption by UK farmers using Bayesian model averaging: the case of organic production and computer usage, *Australian Journal of Agricultural and Resource Economics* 55: 1-20.

Simar L., P. Wilson (1998) Sensitivity analysis of efficiency scores: How to bootstrap in nonparametric frontier models, *Management Science* 44(1): 49-61.

Simar L., P. Wilson (1999) Estimating and bootstrapping Malmquist indices, *European Journal of Operational Research* 115: 459-471.

Simar L., P. Wilson (2000) A general methodology for bootstrapping in nonparametric frontier models, *Journal of Applied Statistics* 27(6): 779-802.